

Operations User's Guide

JSC Reduced Gravity Program

User's Guide

Aircraft Operations Division

Revision D

October 2000



National Aeronautics and
Space Administration
Lyndon B. Johnson Space Center
Houston, Texas

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 2 of 165

JSC Reduced Gravity Program User's Guide

October 2000

Revision D

Approved by

Original Signed by

Robert J. Naughton
Chief, Aircraft Operations Division

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 3 of 165

Change Record

Rev.	Date	Document OPR/ Custodian/Extension Alternate/Extension	Description
A	November 1996	Judy Rickard x49113	
B	November 1997	Judy Rickard x49113	Removed Medical Examination Requirements and Physiological Training Requirements
C	March 1998	Judy Rickard x49113	Added Appendix F, Medical Examination Requirements, Appendix G, Physiological Training Outline and Appendix K, Customer Feedback Form
PCN-1	November 1999	John S. Yaniec x49211	Test Director name change, and removed some of the Medical Examination Requirements, Appendix F
D	October 2000	John S. Yaniec x49211	Thorough update of entire document.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 4 of 165



MISSION STATEMENT

To provide a world-class, reduced gravity research platform that emphasizes user compatibility, quality reduced gravity levels, and a customer-oriented support organization.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 5 of 165

Acknowledgements

The following document is the product of hard work and dedication of many individuals. A special thanks to the men and women listed below:

Johnson Space Center

John R. Bain, Andrew Nash, Troy Whitney, John Lamb, Brian Barnett,
Brandy Quarles, Michael Fox, Mark Sowa, David Tharp, Don Snyder,
Jack Orsak, Charlyne Minick, Charles K. LaPinta, M.D.

Glenn Research Center

Eric Neumann, James Withrow, Michael Dobbs, Chris Hegedus, John Kolis

Marshall Space Flight Center

Jeff Mullins

Texas Space Grant Consortium

Debbie Mullins

John S. Yaniec
Lead Test Director
KC-135 Reduced Gravity Program

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 6 of 165

Table of Contents

1	KC-135 USER'S GUIDE INTRODUCTION	11
1.1	Introduction	11
1.2	Purpose	11
1.3	Scope	12
1.4	Reduced Gravity Office Contact Information	12
1.5	Information on How to Apply for NASA Microgravity Research Grants	12
1.6	List of Acronyms	13
1.7	Local Area Information	16
1.7.1	Maps	16
1.7.2	Restaurants	19
1.7.3	Hotels	21
1.7.4	Hardware / Specialty Stores	23
2	SAFETY POLICY	24
2.1	Johnson Space Center Requirements	24
2.2	Aircraft Operations Division Requirements	24
2.3	Human Research Policy	25
2.4	Test Personnel	25
2.5	Test Equipment Data Package	25
2.6	Test Readiness Review	26
2.7	Flight Crew	26
3	FACILITIES PROVIDED	28
3.1	Aircraft	28
3.1.1	Cabin Environment	29
3.1.2	Cabin Dimensions	29
3.1.3	Cabin Provisions	33
3.1.4	Electrical Power and Interface	34
3.1.5	Aircraft Lighting	38
3.1.6	High Pressure Gas System	38
3.1.7	Overboard Vent System	39
3.1.8	Aircraft G-Load Display	41
3.1.9	Accelerometer Signal	41
3.1.10	On-Board Tools	42
3.2	Photographic and Videographic Support	42
3.3	Ground Facilities	45
3.3.1	Reduced Gravity Office	45
3.3.2	Computers, Network Access, Printers, and Phones	46
3.3.3	Normal Duty Hours	46
3.3.4	Security	46
3.3.5	Equipment and Material Storage	46
3.3.6	Cryogenic Storage and Supply System	46
3.3.7	Shipping and Receiving	47
3.3.8	Crane and Scale	47
3.3.9	Forklift	48
3.3.10	Ground Tools	48
3.3.11	Loading Assistance Tools	48

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 7 of 165

3.4	Flight Medicine	49
3.4.1	Motion Sickness Medication	49
3.4.2	Medical Facilities	49
3.4.3	Flight Surgeon Crew Duties	49
4	USER REQUIREMENTS	51
4.1	Test Request Procedure	51
4.2	Human Research Protocol	52
4.3	Test Personnel Requirements	53
4.3.1	Medical Requirements	53
4.3.2	Physiological Training Requirements	54
4.3.3	Medical and Physiological Documentation	55
4.3.4	Badging Requirements	55
4.3.5	Visitors	57
4.3.6	Mishap Form	57
4.3.7	KC-135 Safety Training	57
4.3.8	Accident and Life Insurance Notification	58
4.4	Funding	58
4.5	Timeline	59
5	TEST DESIGN REQUIREMENTS	60
5.1	Test Equipment Structural Design Requirements	60
5.2	Aircraft Loading	64
5.3	Pressure/Vacuum System Requirements	65
5.3.1	Classification Requirements	65
5.3.2	Pressure System Design Requirements	66
5.3.3	Pressure System Test and Inspection Requirements	68
5.4	Electrical	70
5.5	Free Float	72
5.6	Overboard Vent	72
5.7	Laser	74
5.7.1	Class Designation	74
5.7.2	Protective Housings	74
5.7.3	Equipment Labels	74
5.7.4	Viewing Portals and Collecting Optics	75
5.8	Emergency Procedures	75
5.9	Hazardous Materials	75
5.10	User Tools	75
5.11	Miscellaneous Guidelines	76
5.12	Containment of Loose Parts and Equipment	78
5.13	Spill Control	78
5.14	EMI/RFI Checks	78
5.15	Cleaning Equipment for Zero-G Flight	78
5.16	Touch Temperature for Research Hardware	79
5.17	KC-135 Noise Levels	79
6	TEST EQUIPMENT DATA PACKAGE REQUIREMENTS	81
6.1	Cover Page	82
6.2	Quick Reference Data Sheet	82

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 8 of 165

6.3	Table of Contents	84
6.4	Flight Manifest	84
6.5	Experiment Background.....	84
6.6	Experiment Description.....	84
6.7	Equipment Description.....	84
6.8	Structural Analysis	85
6.9	Electrical Analysis.....	86
6.9.1	Schematic	86
6.9.2	Load Tables	86
6.9.3	Electrical Kill Switch	87
6.9.4	Loss of Electrical Power	87
6.10	Pressure/Vacuum System Documentation Requirements	87
6.11	Laser Certification.....	90
6.12	Parabola Details and Crew Assistance	90
6.13	Institutional Review Board.....	91
6.14	Hazard Analysis Report Guidelines	91
6.15	Tool Requirements	96
6.16	Photo Requirements	96
6.17	Aircraft Loading.....	96
6.18	Ground Support Requirements.....	97
6.19	Hazardous Materials.....	97
6.20	Material Safety Data Sheets	98
6.21	Experiment Procedures Documentation.....	98
6.22	Bibliography.....	99
7	TEST OPERATIONS.....	100
7.1	Pre-Flight.....	100
7.2	In-Flight.....	100
7.3	Post-Flight	101

APPENDICES:

A – Reduced Gravity Investigation Approval Questionnaire	102
B – JSC Reduced Gravity Program Test Readiness Review Certification	103
C – Medial Requirements.....	104
D – Physiological Training Outline	123
E – Human Research Master Protocol	130
F – NASA/JSC Human Research Informed Consent.....	135
G – Zero G Video Dub Request Form	139
H – Glenn Research Center Operations Requirements.....	140
I – Pre-Shipment Equipment Readiness Checklist	152
J – 473A NASA/JSC Badge Request Form	155
K –473B NASA/JSC Request form for Foreign National Visitor/Employees from Designated Areas	158
L - JSC Customer Feedback Form.....	161
INDEX.....	163

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 9 of 165

Table of Figures

Figure 1	: Map of Clear Lake	16
Figure 2	: Map of Ellington Field	17
Figure 3	: Map of Johnson Space Center	18
Figure 4	: KC-135 Aircraft	28
Figure 5	: Parabola Diagram	29
Figure 6	: Aircraft Floor Layout	30
Figure 7	: Cross-Section of Fuselage Station 710 and Aft	31
Figure 8	: Cross-Section of Fuselage Station 710 and Fwd	32
Figure 9	: Cargo Door Dimensions in Inches	33
Figure 10	: Picture of Cargo Door Operations	33
Figure 11	: Power Distribution Panel	34
Figure 12	: MS Cannon Receptacle (Left) and Plug (Right)	35
Figure 13	: 14S-9 Receptacle Contact Arrangement	36
Figure 14	: 16-13S Receptacle Contact Arrangement	36
Figure 15	: 28-5 Receptacle Contact Arrangement	36
Figure 16	: 16-13S Receptacle Contact Arrangement	37
Figure 17	: 22-2S Receptacle Contact Arrangement	37
Figure 18	: 24-22 Receptacle Contact Arrangement	38
Figure 19	: Overboard Vent Line	40
Figure 20	: DB-15 Accelerometer Data Connector	41
Figure 21	: Aircraft Acceleration Vectors	42
Figure 22	: Picture of Ground Facilities	45
Figure 23	: Picture of Building 993 High Bay Work Area	45
Figure 24	: Picture of Building 993 High-Bay Crane	47
Figure 25	: Picture of High Lift Truck	48
Figure 26	: Picture of Researchers in the Altitude Chamber	53
Figure 27	: Sonoluminescence in Space (Glynn Holt – Boston University)	60
Figure 28	: Test Cabin Floor Schematic	62
Figure 29	: Cargo Strap Schematic	62
Figure 30	: Stud/Spacer Floor Attachment Assembly	63
Figure 31	: Picture of Fully Loaded Aircraft	64
Figure 32	: Picture of Free-Float Experiment	72
Figure 33	: Overboard Vent Line	73
Figure 34	: Glenn Research Center Buildings 101 & 4	140
Figure 35	: Building 101 (Exterior and High-Bay)	142
Figure 36	: Local Hotels and Restaurants at Glenn Research Center	147
Figure 37	: Local Area Map of Glenn Research Center	148
Figure 38	: Glenn Research Center Map	149

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 10 of 165

Table of Tables

Table 1	: Total Electrical Test Power	34
Table 2	: Flow Rates	40
Table 3	: Accelerometer Pin Designations	41
Table 4	: Floor Attachment Hardware	61
Table 5	: Minimum Wire Gauges	71
Table 6	: Overboard Vent Flow Rates	73
Table 7	: Example Load Table.....	87
Table 8	: Pressure System Design Specifications.....	88

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 11 of 165

1 KC-135 USER'S GUIDE INTRODUCTION

1.1 Introduction

The Reduced Gravity Program, operated by the National Aeronautics and Space Administration (NASA), Lyndon B. Johnson Space Center (JSC) in Houston, Texas, provides a "weightless" environment, similar to the environment of space flight. This is done on a cost reimbursable basis for research and training purpose. For those researchers who have NASA research grants, are being funded by NASA or another government agency, have a Memorandum of Understanding (MOU), or Space Act Agreements with NASA, the cost reimbursable basis provides the mechanism for flying an experiment aboard the KC-135.

The reduced gravity environment is achieved by flying a modified Boeing KC-135 turbo jet through a series of parabolic maneuvers. This results in short periods of less than one "g" acceleration. The lengths of these reduced gravity periods depend on the "g" level required for the specific test. Listed below are typical lengths for various maneuvers:

Negative-g to -1/10 max	15 seconds
Zero-g 0-g	23 seconds
Lunar-g 1/6-g (.16)	30 seconds
Martian-g 1/3-g (.38)	40 seconds

These maneuvers may be flown consecutively, (i.e, roller coaster fashion), or separated by enough time to alter the test setup. Each parabola is initiated with a 1.8-g pull-up and terminated with a 1.8-g pullout. Normal mission, lasting approximately two hours consist of 40 parabolic maneuvers, originate and terminate at Ellington Field, Houston, Texas. Changes to the normal mission profile can be made to ensure more efficient test operations. These changes include number of parabolas performed, g level adjustments (i.e. .16, .38, .1, .5), and length of breaks between parabolas or sets of parabolas. Requests for operations away from Ellington Field will be considered on an individual basis addressing the benefit to NASA, fiscal soundness, scientific merit, airspace accessibility, and overall Reduced Gravity Program schedule impact.

The KC-135 aircraft test area is equipped with electrical power, compressed gas, an overboard vent, accelerometer data, and photo lights. NASA JSC can provide photographers for still photography and video coverage. An S-band video downlink with two-way audio capability may also be requested. Workspace is available on the ground for buildup and checkout of test equipment to ensure its operation before installation in the airplane.

1.2 Purpose

The purpose of this user's guide is to provide a guideline for existing and potential users of the Reduced Gravity Program. This document outlines safety requirements, presents a description of the Reduced Gravity Program facilities, details user and test equipment requirements, explains the Test Equipment Data Package, and provides information on pre-flight, post-flight, and in-flight test operations.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 12 of 165

1.3 Scope

This work instruction applies to all users and potential users of the JSC Reduced Gravity Program.

1.4 Reduced Gravity Office Contact Information

Any questions concerning this document, the program, test requirements, test schedules, etc., should be directed to:

Reduced Gravity Office
 Building 993
 Ellington Field
 Houston, Texas 77034
 Call 281-244-9874, fax 281-244-9500 or E-mail: zerogl@jsc.nasa.gov

1.5 Information on How to Apply for NASA Microgravity Research Grants

Researchers interested in conducting Reduced Gravity research aboard the KC-135 Reduced Gravity Aircraft must have a NASA grant or be sponsored by NASA or another federal government agency. Information on how to apply for a NASA grant in the areas of Life and Material Sciences can be found at: www.hq.nasa.gov/office/olmsa

References

JSC-20483, JSC Institutional Review Board
 JSC Safety Manual (JPG 1700.1H)
 KC-135 Test Equipment Inspection Procedures
 JSC 12454, Maintenance, Engineering, and Quality Procedures
 JSC Form 8500, Report of Medical Examination
 JSC Form 902, Customer Feedback
 JSC Document 2156
 Deutsche-Luft-und Raumfahrt
 JHB 1710.13B Design, Inspection, and Certification of Pressure Vessels and Pressurized Systems
 American National Standards Institute (ANSI) Z-136.1 Safe Use of Lasers
 Federal Standard W-C-596/90
 Federal Standard W-C-596/91A
 NEMA L5-30P

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 13 of 165

1.6 List of Acronyms

A	Ampere
AC	Alternating Current
AN	Army/Navy
ANSI	American National Standards Institute
AOD	Aircraft Operations Division
ASME	American Society of Mechanical Engineers
ATC	Air Traffic Control
AWS	American Welding Society
C	Celsius
CD-ROM	Compact Disc – Read Only Memory
CFR	Code of Federal Regulations
CG	Center of Gravity
CRT	Cathode Ray Tube
DC	Direct Current
DLR	Deutsche Luft-und Raumfahrt
DIA	Diameter
DO	Doctor of Osteopathic Medicine
DOD	Department of Defense
DOT	Department of Transportation
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ERVB	Escort Required Visitor Badge
F	Fahrenheit
FAA	Federal Aviation Administration
FBD	Free Body Diagram
FCOD	Flight Crew Operations Directorate
FDA	Food & Drug Administration
FOD	Foreign Object Debris
FS	Fuselage Station
GFCI	Ground Fault Circuit Interrupter
GRC	Glenn Research Center
Hz	Hertz

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 14 of 165

HVAC	Heating Ventilation and Air Conditioning
IACUC	Institutional Animal Care Use Committee
IND	Investigational New Drug
IRB	Institutional Review Board
JHB	Johnson HandBook
JSC	Johnson Space Center
LBS	Pounds
MAWP	Maximum Allowable Working Pressure
MOU	Memorandum of Understanding
MPE	Maximum Permissible Exposure
MS	Military Specification
MSDS	Material Safety Data Sheet
MSFC	Marshall Space Flight Center
NAS	National Aerospace Standard
NASA	National Aeronautics and Space Administration
NBL	Neutral Buoyancy Lab
NEMA	National Electrical Manufactures Association
NPT	National Pipe Thread
OD	Olive Drab
PI	Principal Investigator
PRV	Pressure Relief Valve
PSI	Pounds per Square Inch
RGO	Reduced Gravity Office
RSA	Russian Space Agency
S&LSD	Space and Life Sciences Directorate
SAE	Society of Automotive Engineers
SCFM	Specific Cubic Feet per Minute
SCTF	Sonny Carter Training Facility
SVHS	Super Vertical Hi-Scan
TEDP	Test Equipment Data Package
TRR	Test Readiness Review
UPS	Uninterruptable Power Supply
UHF	Ultra-High Frequency

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 15 of 165

URL	Uniform Resource Locator
USAF	United States Air Force
V	Volt
VAC	Volts Alternating Current
VCR	Video Cassette Recorder
VDC	Volts Direct Current
VHS	Vertical Hi-Scan

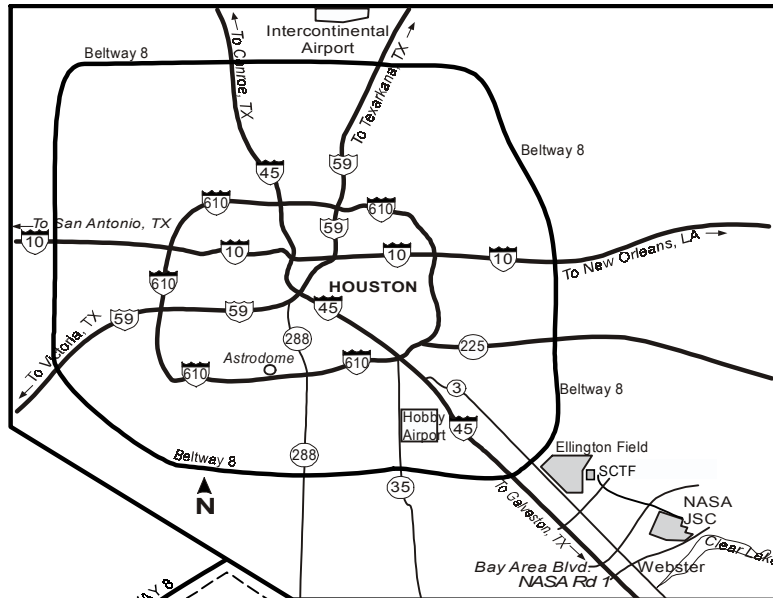
Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 16 of 165

1.7 Local Area Information

This section provides information on the area surrounding the Johnson Space Center. It is provided as an aid to researchers and guests and is not intended as any sort of endorsement.

1.7.1 Maps



MAP OF THE CLEAR LAKE AREA

The Neutral Buoyancy Lab (NBL) is located in the Sonny Carter Training Facility (SCTF)

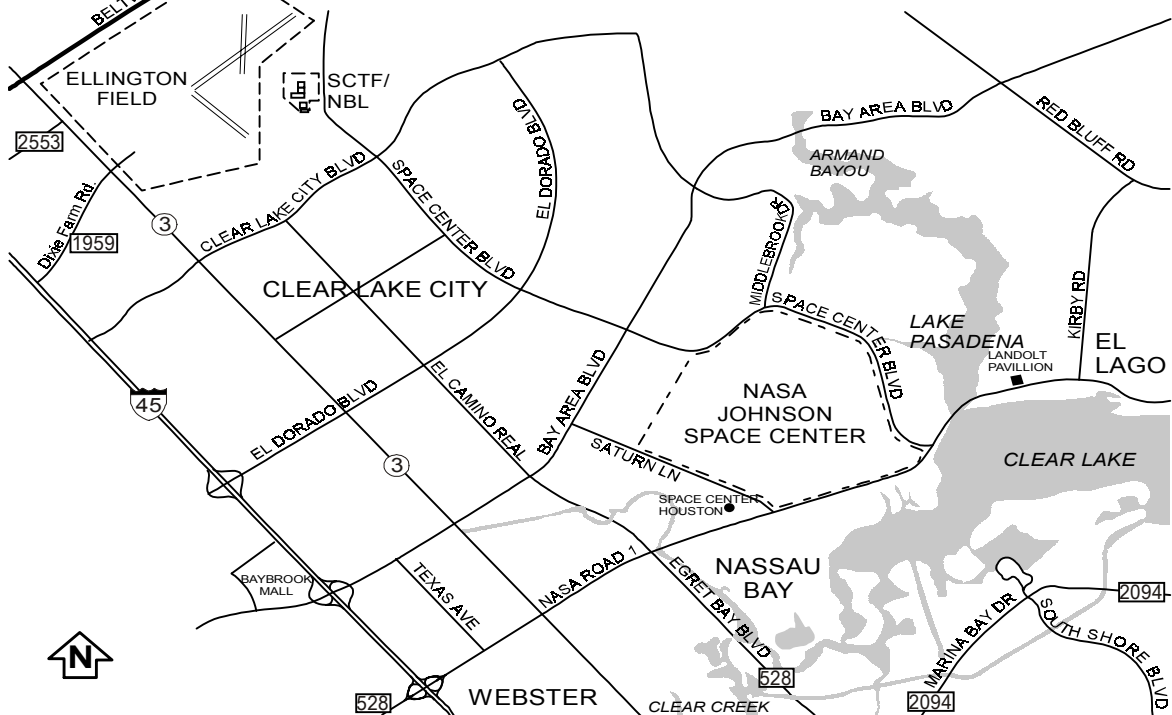


Figure 1: Map of Clear Lake

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 17 of 165

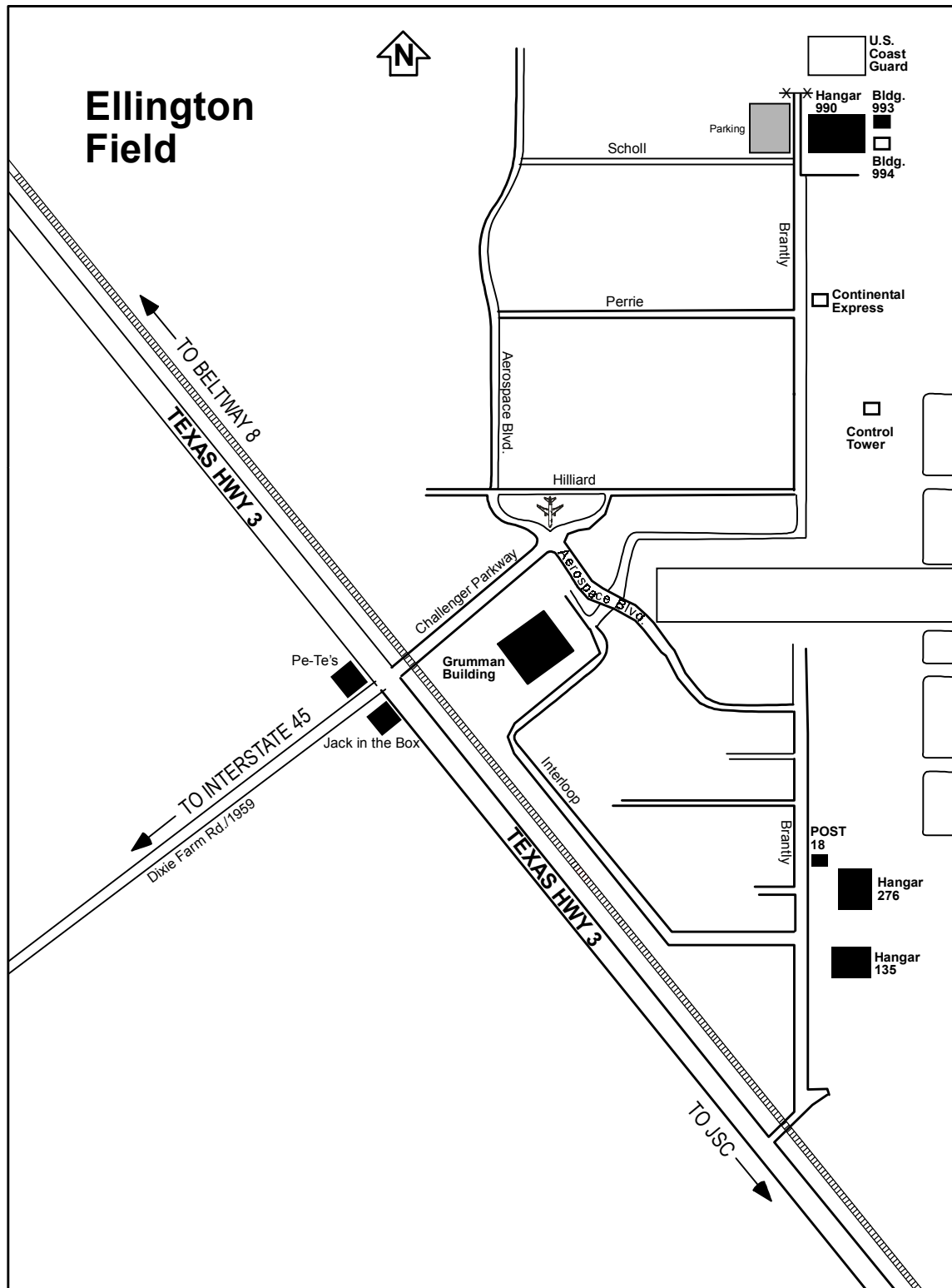


Figure 2: Map pf Ellington Field

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 19 of 165

1.7.2 Restaurants

Name	Address	Telephone
Angelo's Pizza & Pasta	400 W Bay Area Blvd.	281-332-2404
Antonini's Subs & Steaks	17314 Hwy. 3	281-338-1305
Arby's Roast Beef Restaurant	2415 Bay Area Blvd	281-486-9865
Ashley's Donuts	2160 Bay Area Blvd	281-486-5644
Avenue Pizza	10810 Hughes Rd	281-484-5000
Black-Eyed Pea	Hwy 3 & Bay Area Blvd	281-338-2571
Bradley's Restaurant & Brewery	515 W Bay Area Blvd	281-332-8488
Burger King	515 El Dorado Blvd	281-486-8780
Cajun Corner	10904 Scarsdale Blvd	713-464-6809
Cappriccio's Pizza N Subs	341 El Dorado Blvd	281-488-2838(delivery only)
Cazzo's Mexican Restaurant	2200 W Bay Area Blvd	281-992-1152
Churrascos	1320 W Bay Area Blvd	281-461-4100
Coffee Oasis (Sandwich Shop)	1606 Clear Lake City Blvd	281-488-8333
Colosseum Italian Restaurant	16608 El Camino Real	281-488-0731
Dairy Queen	225 El Dorado Blvd	281-286-4717
Don Pico's Mexican Restaurant	2110 Bay Area Blvd	281-280-8081
Domino's Pizza	1845 El Dorado Blvd.	281-480-7533
Double Dave's Pizza Works	Bay Area & Space Center Blvd.	281-286-DAVE
El Lago Burrito Co.	1227 Bay Area @ Diana	281-461-0202
Franco Italian Restaurant	1101 E. NASA Rd 1	281-488-2207
Gardenia Mexican Restaurant	622 FM 1959 (Dixie Farm Rd.)	281-464-0988
Grandy's Restaurant	1005 Bay Area Blvd.	281-486-9696
Jack-In-The-Box	321 FM 359 S (Ellington Field/Hwy. 3)	281-375-5224
Jack-In-The Box	418 El Dorado Blvd.	281-286-4816
Jason's Deli	541 W Bay Area Blvd.	281-338-8000
Kentucky Fried Chicken	1945 El Dorado Blvd.	281-488-8532
Little Caesars Pizza	576 El Dorado Blvd.	281-486-4041
McDonald's	534 ½ El Dorado Blvd.	281-488-3326

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 20 of 165

Name	Address	Telephone
Mr. Gatti's Pizza (Buffet)	16607 El Camino Real @ Bay Area	281-332-2000
Ninfa's Mexican Restaurant	463 Bay Area Blvd.	281-480-4090
Olive Garden	18976 Gulf Frwy.	281-488-1022
Outback Steakhouse	481 W Bay Area Blvd.	281-338-6283
Perry's Grille & Steakhouse	487 Bay Area Blvd.	281-286-8800
Perry's Italian Kitchen	1001 Pineloch Dr.	281-488-2626
Pe-Te's Cajun BBQ Restaurant	11902 Galveston Rd. (Hwy. 3)	281-481-8736
Piccadilly Cafeteria	2465 Bay Area Blvd.	281-480-5453
Pizza Inn	15148 Galveston Rd. (Hwy. 3)	281-480-0011
Quizno's Classic Subs	16801 El Camino Real	281-282-9700
Salad Express	595 W Bay Area Blvd.	281-338-2791
Sonic Drive-In	310 W Bay Area Blvd.	281-338-9931
Steak & Ale	19222 I-45, Baybrook Mall	281-486-9115
Sweet Mesquite: a South TX Grill	Bay Area Blvd. & Space Center Blvd.	281-338-2571
Subway Sandwich Shop	1190 Clear Lake City Blvd.	281-461-6162
Subway Sandwich Shop	534 El Dorado Blvd.	281-486-8636
Tommy's Patio Café	2555 Bay Area Blvd.	281-480-2221
Village Pizza & Seafood	2314 W Main, League City	281-332-3606
Wendy's	16402 El Camino Real	281-488-4376

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 21 of 165

1.7.3 Hotels

Name	Address	Telephone
Beacon Hill Guest House Bed & Breakfast	3705 NASA Rd One, Seabrook, TX 77586	281-326-7643
Best Western Inn	889 W Bay Area Blvd., Webster, TX 77598	281-338-6000
Best Western Inn	8600 Gulf Frwy.	713-910-8600
Boardwalk Inn	8 Waterfront, Kemah, TX 77565	281-334-9880
Candlewood Hotel Co.	2737 Bay Area Blvd., Houston, TX 77058	281-461-3060
Captain's Quarters Bed & Breakfast	701 Bay Avenue, Kemah, TX 77565	281-334-4141
Comfort Inn	750 W NASA Rd. 1, Webster, TX 77598	281-332-1001
Courtyard by Marriott	9190 Gulf Frwy., Houston, TX 77017	713-910-1700
Fairwind Corp. Lodging	15900 Space Center Blvd., Houston 77062	281-488-4945 888-833-2677
Hilton Nassau Bay & Marina	3000 NASA Rd. 1, Houston, TX 77058	281-333-9300
Holiday Inn Express	2720 NASA Rd. 1, Seabrook, TX 77058	281-326-7200
Holiday Inn NASA	1300 NASA Rd. 1, Houston, TX 77058	281-333-2500
Homegate Studios & Suites NASA	720 W Bay Area Blvd., Webster, TX 77598	281-316-1182
Homestead Village	12700 Featherwood Dr., Houston, TX	281-929-5400
Homewood Suites	401 Bay Area Blvd., Houston, TX 77058	281-486-7677
Marina Park Inn	601 Texas Ave., Kemah, TX 77565	281-334-4855
Microtel Inn and Suites	1620 NASA Rd. One, Houston, TX 77058	281-335-0800

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 22 of 165

Name	Address	Telephone
Motel 6	1001 W NASA Rd. One, Webster, TX 77598	281-332-4581
Park Inn Intern'l @ the Marina	601 Texas Ave., Kemah, TX	281-344-4855
Pelican House Bed & Breakfast	1302 1st St., Seabrook, TX 77586	281-474-5295
Quality Inn	904 NASA Rd. One, Houston, TX 77058	281-333-3737
Ramada Inn South NASA	1301 NASA Rd. One, Houston, TX 77058	281-488-0220
Residence Inn	525 Bay Area Blvd., Houston, TX 77058	281-486-2424
South Shore Harbour Resort	2500 S Shore Blvd., League City, TX 77573	281-334-1000
Super 8 Motel	18103 King's Row, Clear Lake, TX	281-333-5385
Towneplace Suites Houston Clearlake	1050 Bay Area Blvd., Houston, TX 77058	281-286-2132

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 23 of 165

1.7.4 Hardware / Specialty Stores

Name	Address	Telephone
Ace Hardware	3902 NASA Rd 1	281-326-3300
Allied Ace Hardware	5203 Fairmont, Pasadena	281-487-9288
Computer Electronics, Etc.	110 E. Medical Center Blvd.	281-286-5510
Friendswood Hardware & Supply	203 W Edgewood Ave	281-482-3487
Home Depot	1514 E. Broadway (SR518) @ Dixie Farm Rd	281-993-1111
Home Depot	20251 Gulf Frwy. (@ NASA Rd. 1), Webster	281-554-2420
Home Depot	11820 Dickinson Rd. (I-45 Southbound @ Bltwy. 8)	281-464-2080
K-Mart	1001 W Bay Area Blvd. (@ I-45 Northbound)	281-338-1888
Lowe's	2741 E. Broadway (SR518) north of Dixie Farm Rd	281-412-6300
Matheson Tri-Gas Inc.	2200 Houston Ave Houston, TX 77007	713-869-7351
Praxair Industrial Gases	9200 Telephone Road Houston, TX 77075	713-991-8700
Pearland Lumber & Ace Hardware	2027 N Main St.	281-485-1474
Sears Hardware Store	2422-A Bay Area Blvd. (@ Space Center Blvd.)	281-488-6786
Sears Hardware Store	11293 Fuqua (@ I-45 Southbound)	713-910-0330
Sears, Roebuck & Co.	300 Baybrook Mall	281-486-3174
Space City Ace Hardware	3902 NASA Rd. 1	281-326-3300
Target	1425 W Bay Area Blvd. (@ I-45, Baybrook Mall)	281-338-1514
Wal-Mart	20810 I-45 (Southbound @ NASA Rd. 1)	281-338-1208

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 24 of 165

2 SAFETY POLICY

The JSC Reduced Gravity Program is operated in accordance with established NASA safety procedures. Due to the critical nature of this program, a multi-stage review and approval procedure has been developed to ensure flight safety. Approval from multiple authorities is required prior to flight. The policies and requirements set forth in this document must be strictly adhered to.

This section describes the general safety policies that all personnel and equipment must comply with in order to occupy, work, and operate on NASA property. Please contact the Reduced Gravity Office with any questions regarding safety aspects at Ellington Field.

2.1 Johnson Space Center Requirements

All personnel and equipment arriving at Johnson Space Center, including the Neutral Buoyancy Lab and Ellington Field, must adhere to all JSC safety guidelines as stated in the JSC Handbook for Safety, Health, and Protection (please refer to JPG 1700.1H). Contact the Reduced Gravity Office (RGO) to request a copy.

2.2 Aircraft Operations Division Requirements

All personnel and equipment arriving at Ellington Field must adhere to the following safety guidelines. A safety briefing will be given to all researchers upon arrival at Ellington Field.

- 1) In the event of an emergency at Ellington Field, **dial x44444** from any NASA phone to immediately contact an Emergency Action Team.
- 2) Identification badges issued by JSC Security must be displayed at all times while on NASA property.
- 3) KC-135 researchers and visitors must stay within the immediate vicinity of Building 993 (Reduced Gravity Office/High Bay). Occupation of any other Ellington Field location is not allowed unless escorted by a NASA AOD badged employee.
- 4) Smoking is discouraged, but allowed in designated areas. Food and drink is only allowed in designated areas.
- 5) Loose items such as pencils, clothing, jewelry, badges, etc. must be accounted for at all times in order to prevent Foreign Object Debris (FOD) problems with the aircraft.
- 6) All trash must be carefully placed in provided trash receptacles. Use specialty trash receptacles for batteries, oil rags, chemicals, etc.
- 7) Stay 15 feet away from all aircraft in Hangar 990 unless escorted by a NASA AOD badged employee.
- 8) Do not walk out onto the flight line (location where aircraft/ground support equipment is operated outside the hangar) unless escorted by a NASA AOD badged employee. Be aware of the flight line road immediately in front of the Reduced Gravity Office (Building 993). Aircraft tugs, vans, and golf carts. frequently travel along the road and pose a hazard to pedestrians in that area.
- 9) Stay at least 200 feet away from all operating aircraft engines.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 25 of 165

- 10) Hearing protection is required during all outdoor and flight operations. Foam earplugs are provided through the Reduced Gravity Office (RGO). (See paragraph 5.17 for OSHA Standards and recorded noise level on the KC-135)
- 11) Storage of equipment must be approved by the RGO prior to its arrival at Ellington Field. All equipment must be, properly labeled upon its arrival.
- 12) All equipment (tools, test hardware, fluids, etc.) brought to Ellington Field must be inventoried and accounted for at all times.
- 13) There will be no unattended operation of research or other equipment on the aircraft or in Building 993. Someone familiar with the shut down procedures will be in attendance during any equipment operation. If an experiment is operating unsupervised the test director **will** power the experiment down.

2.3 Human Research Policy

All JSC Reduced Gravity Program investigations involving human test subjects, animals, or biological tests must submit a JSC Institutional Review Board (IRB) protocol and obtain written approval prior to the Test Readiness Review.

2.4 Test Personnel

Each researcher will keep the number of personnel that are required to fly to a minimum. Only test personnel with a demonstrated need to participate in the investigation will be allowed to fly. All personnel are required to wear approved flight suits and proper footwear during the flight.

Blue flight suits will be worn by FLIGHT CREW PERSONNEL ONLY (Pilots, Flight Engineers, Test Directors, Flight Surgeons, Video and Still Photographers, and Astronauts). All researchers will wear the Olive Drab (OD) flight suits. The Reduced Gravity Office provides the (OD) green flight suits on loan. There is no requirement for researchers to purchase their own flight suits. Researchers that wish to purchase their own flight suits may do so, however, flight suits **must** be made of NOMEX III material and the **only** color allowed is Olive Drab.

Proper footwear is defined as: boots (combat, hiking) or tennis shoes. In all cases the footwear must be clean. Sandals or any open toe foot-ware is **not** acceptable at any time on the aircraft (loading, during flight, off-loading).

2.5 Test Equipment Data Package

Test Equipment Data Packages (TEDP) is required for all experiments requesting flight time on the KC-135. This package is required to provide detailed documentation of an experiment by addressing all aspects of its design. Researchers shall submit **four copies** of this document to the RGO **six weeks** prior to flight, and must be 100% complete in order to initiate its review. Failure to provide a complete and accurate Test Equipment Data Package **six weeks** prior to flight may result in flight disqualification. Any experiment deemed unsafe or not clearly defined through review of a Test Equipment Data Package may also result in flight disqualification or delays. See Section 6 for instructions on how to prepare a Test Equipment Data Package. For those researchers who wish to submit the TEDP electronically, contact the RGO for software requirements.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 26 of 165

2.6 Test Readiness Review

The Test Readiness Review (TRR) is the final safety review of the experiment prior to flight. It includes a complete review of supporting analyses and documentation, an inspection of the test equipment, and a final integrated verification of flight readiness. A TRR is required for **all** test articles, both new and previously flown.

The TRR will be attended by:

- 1) Researcher or a designated representative
- 2) Reduced Gravity Program Test Director
- 3) AOD Quality Assurance Representative
- 4) KC-135 Project Pilot (or designee)
- 5) IRB Representative (when the IRB protocol is involved)
- 6) FCOD Flight Safety Office Representative (or designee)
- 7) JSC Safety Office Representative (or designee)
- 8) Chief, Aircraft Operations Division (Chairman) or a designated representative

Researchers may be required to operate their equipment during the TRR and demonstrate their experiment's emergency shut down procedures.

During the TRR, each experiment will be "approved", "approved pending corrections required", or "not approved" for flight. A unanimous decision from the reviewers is required for flight approval. Experiments that have been denied approval at the TRR may be scheduled for a subsequent review when deficient areas have been corrected. Subsequent reviews are not necessary for experiments that have been approved pending corrections. However, a Test Director must verify that corrections have been made before the equipment will be loaded onto the aircraft. An example of the TRR Certification Form is included in Appendix B.

2.7 Flight Crew

The flight crew for the KC-135 is typically made up of a Pilot in Command, Co-pilot, Flight Engineer, and two Test Directors. When required, a Flight Surgeon, Video, and/or Still photographers will join the flight crew as well. The Pilot in Command is the one who flies the aircraft during takeoff, landing, and during the parabolas. The Pilot in Command is responsible for the aircraft and those researchers assigned to the flight; therefore, he/she has the final say on whether or not the flight will proceed. To start the parabola, the Pilot in Command will initiate the "ON THE PULL" call to the Test Director. Once the Pilot in Command has reached a stable g-level, he or she will give the Test Director the "RELEASE" call.

The Co-Pilot is responsible for all communications with the air traffic control center and also flies the aircraft when the Pilot in Command is unable. During the parabola, the Co-Pilot is responsible for navigation of the aircraft and ensures the aircraft stays within the restricted airspace provided by air traffic control. He or she is also responsible for the throttle settings of the engines during the parabola. The Co-Pilot also gives the "30 LOW"

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 27 of 165

call to the Test Director, indicating the reduced gravity phase of the parabola will end in 3 to 5 seconds.

The Flight Engineer is responsible for monitoring aircraft systems and assisting the pilots during any emergency situations. The Flight Engineer also keeps track of the parabola count and reconfigures the offset of the reduced gravity display in the cockpit for parabolas.

The Test Directors are responsible for all of the activities in the cabin area during both ground and flight operations. The primary job of the Test Directors is SAFETY. During ground phase preparations, the Test Directors lead the Test Readiness Review (TRR) and direct the loading of the experiments onto the aircraft. During the loading, the Test Directors have the final say regarding placement of the experiments, and where and how experiment hardware is attached to the aircraft floor.

During flight operations, the Lead Test Director is in charge of all cabin activities. At any time during the flight, the Test Directors can terminate any experiment they feel is unsafe to continue. The Test Directors communicate with the pilots via the intercom system; therefore, when the Pilot in Command gives the command "ON THE PULL," the Test Director's response is "PULL WHEN READY" this tells the pilot that both the cabin area and researchers are ready to begin a parabola.

When the Pilot in Command says "RELEASE", the Test Director will respond accordingly with "RELEASE" to inform the pilots that the aircraft is at the best possible reduced gravity state for that parabola. When the Co-Pilot says "30 LOW", the Test Director responds with "30 LOW" to tell the pilots that the cabin and the researchers are ready for the end of the reduced gravity phase of the parabola. Once the Test Director responds to the Co-Pilot's "30 LOW" call, he/she will announce to the cabin "FEET DOWN COMING OUT." The announcement to the cabin will give the researchers 3 to 5 seconds to get ready for the end of the reduced gravity phase of the parabola.

Throughout the flight, the Test Directors will help any researcher who is in need of assistance. This may include helping with an experiment or helping a researcher that is having difficulty with motion sickness. In the event of an emergency during flight, the Lead Test Director is in charge of all cabin activity and will inform the Pilot in Command of the nature and status of the emergency.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 28 of 165

3 FACILITIES PROVIDED

This section describes the NASA facilities available to KC-135 researchers.

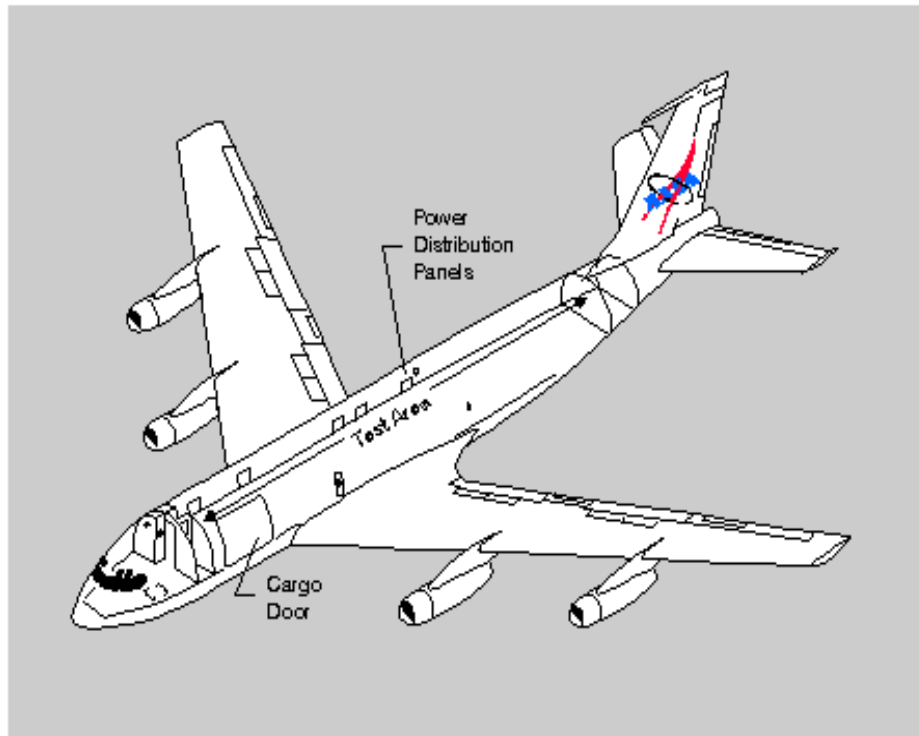


Figure 4: KC-135 Aircraft

3.1 Aircraft

The Boeing KC-135 is a four-engine, swept-wing aircraft similar to the Boeing 707. The USAF primarily operates these aircraft as refueling tankers. This particular KC-135, (subsequently named NASA 931), was manufactured and delivered to the USAF on 22 November 1963. NASA obtained the current KC-135 in November of 1994 and modified it to support the Reduced Gravity Program. The predecessor to NASA 931, NASA 930, was obtained by NASA in 1973 and flew over 58,000 parabolas before it was retired in 1995. It is now on static display at the entry of Ellington Field.

The KC-135 is operated as a public aircraft within the meaning of the Federal Aviation Act of 1958, as amended. As such, it does not require or hold a current airworthiness certificate issued by the FAA. The KC-135 is not operated as a common carrier or as a military transport. Consequently, any individual manifested to board the KC-135 should determine before boarding whether their personal life or accident insurance provides coverage under such conditions. Also, since the aircraft will be used under test conditions, all researchers and test subjects will be fully informed of the test plans and all risks, hazards, and discomforts inherent to such tests prior to flight.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 29 of 165

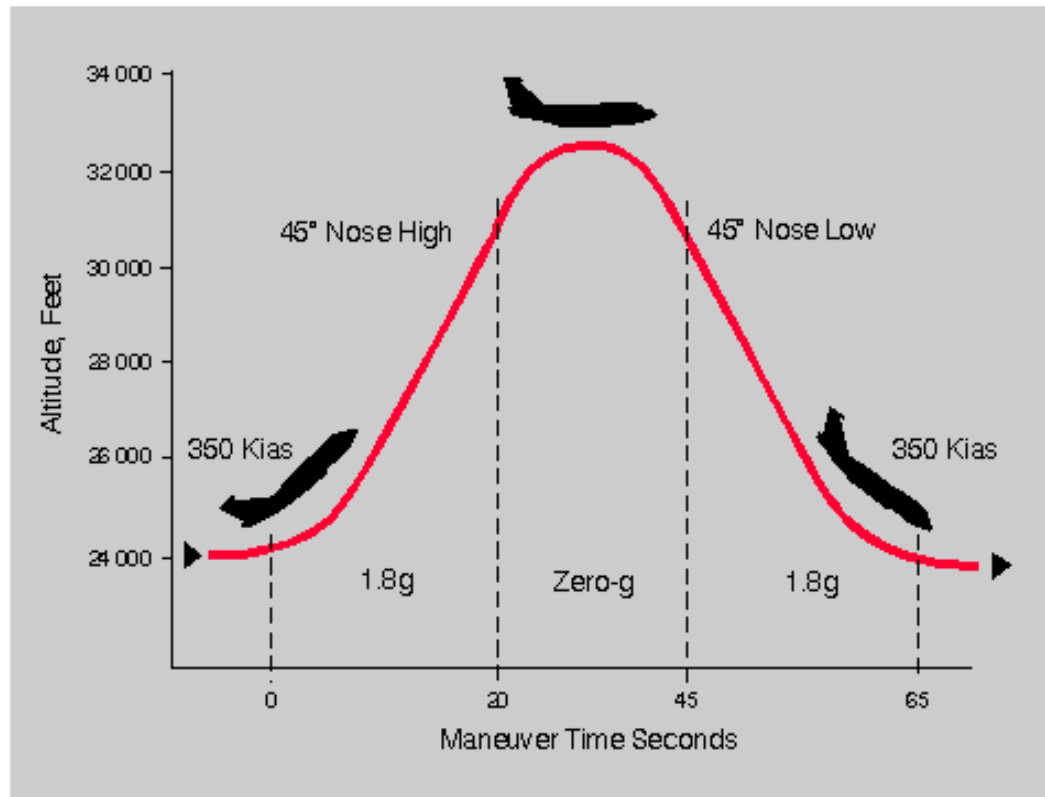


Figure 5: Parabola Diagram

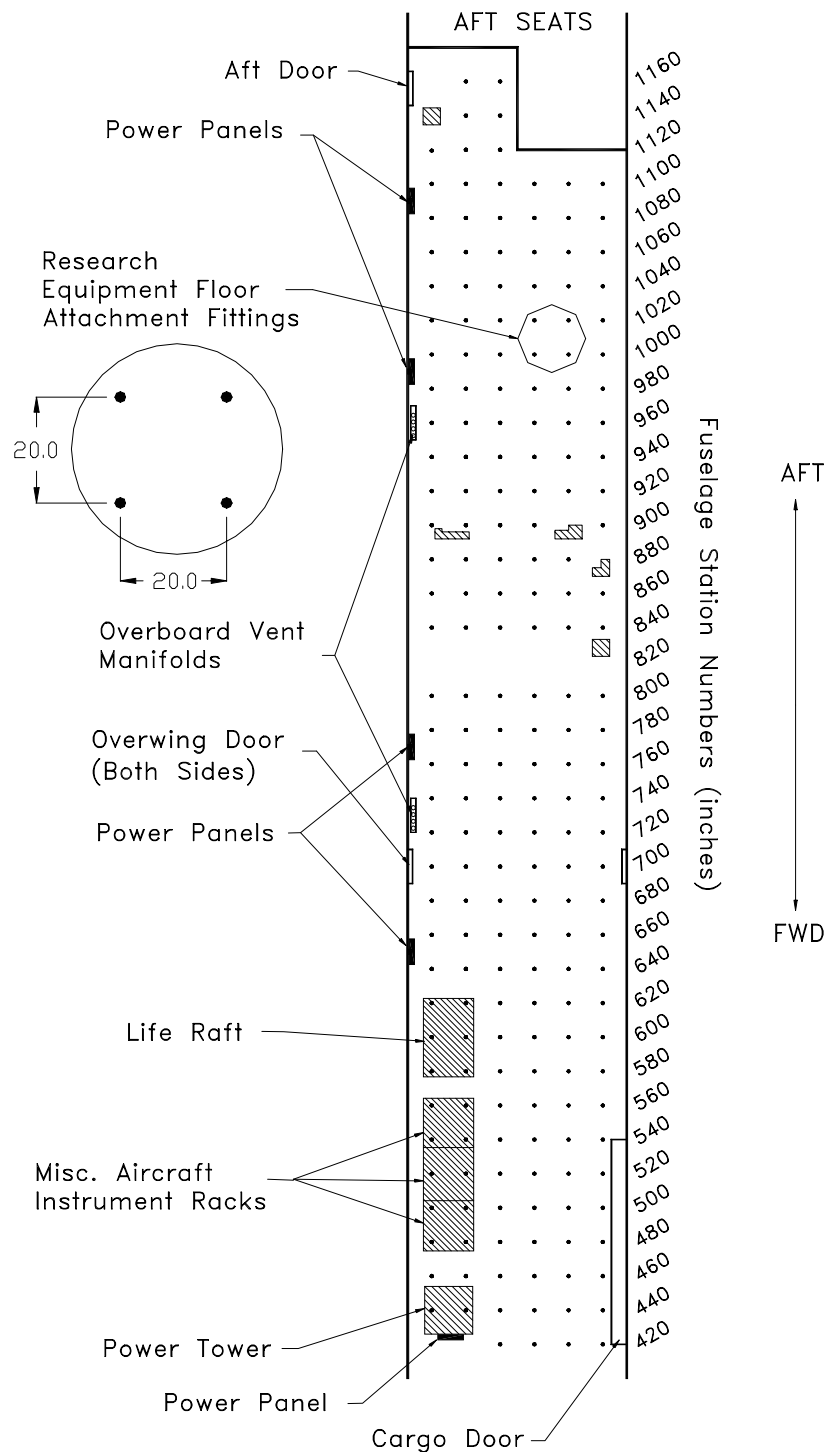
3.1.1 Cabin Environment

Cabin pressure is maintained at approximately pressure altitude 8,000 feet (10.9 psia) during parabolic maneuvers. Loss of cabin pressurization could result in pressure as low as 3.5 psia; a factor that must be considered in the design of test equipment. Normally, cabin temperature varies from 50 to 80 degrees F in flight. The temperature in the cabin is not controlled while the airplane is on the ground; however, a portable ground air conditioner is available during preflight operations. Keep in mind that the aircraft typically sit out on the ramp during the day and overnight during a flight week. Temperature ranges inside the cabin area can be as cold as 30⁰ F during the winter months and as hot as 120⁰ F in the summer. Researchers should make provisions for their experiment hardware to tolerate these conditions.

3.1.2 Cabin Dimensions

Approximately 60 feet of cabin length is available for test purposes. A floor plan schematic is shown in Figure 6. A cross sectional view of the cabin is shown in Figure 7 and Figure 8. Test equipment is usually loaded through the cargo door that is 75 inches high and 118 inches wide. Because of the door actuation mechanism, an area 14 inches tall and 9 inches wide is unusable at each of the top corners of the door. A diagram of the cargo door is shown in Figure 9. A photograph showing the cargo door during loading operations is shown in Figure 10.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 30 of 165



Note: Research equipment installation is prohibited on cross-hatched areas.

Figure 6: Aircraft Floor Layout
Verify that this is the correct version before use.

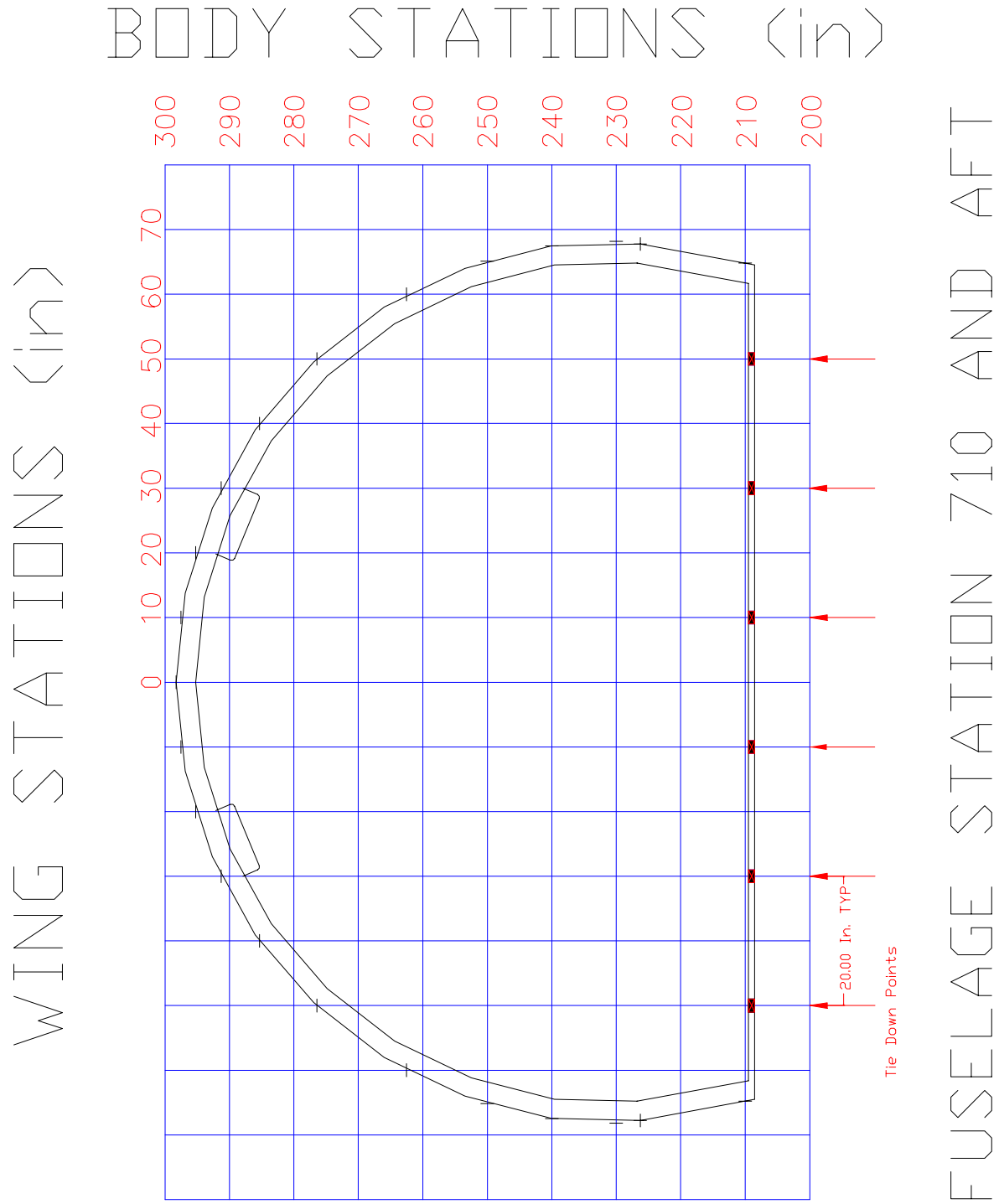


Figure 7: Cross-Section of Fuselage Station 710 and Aft

Verify that this is the correct version before use.

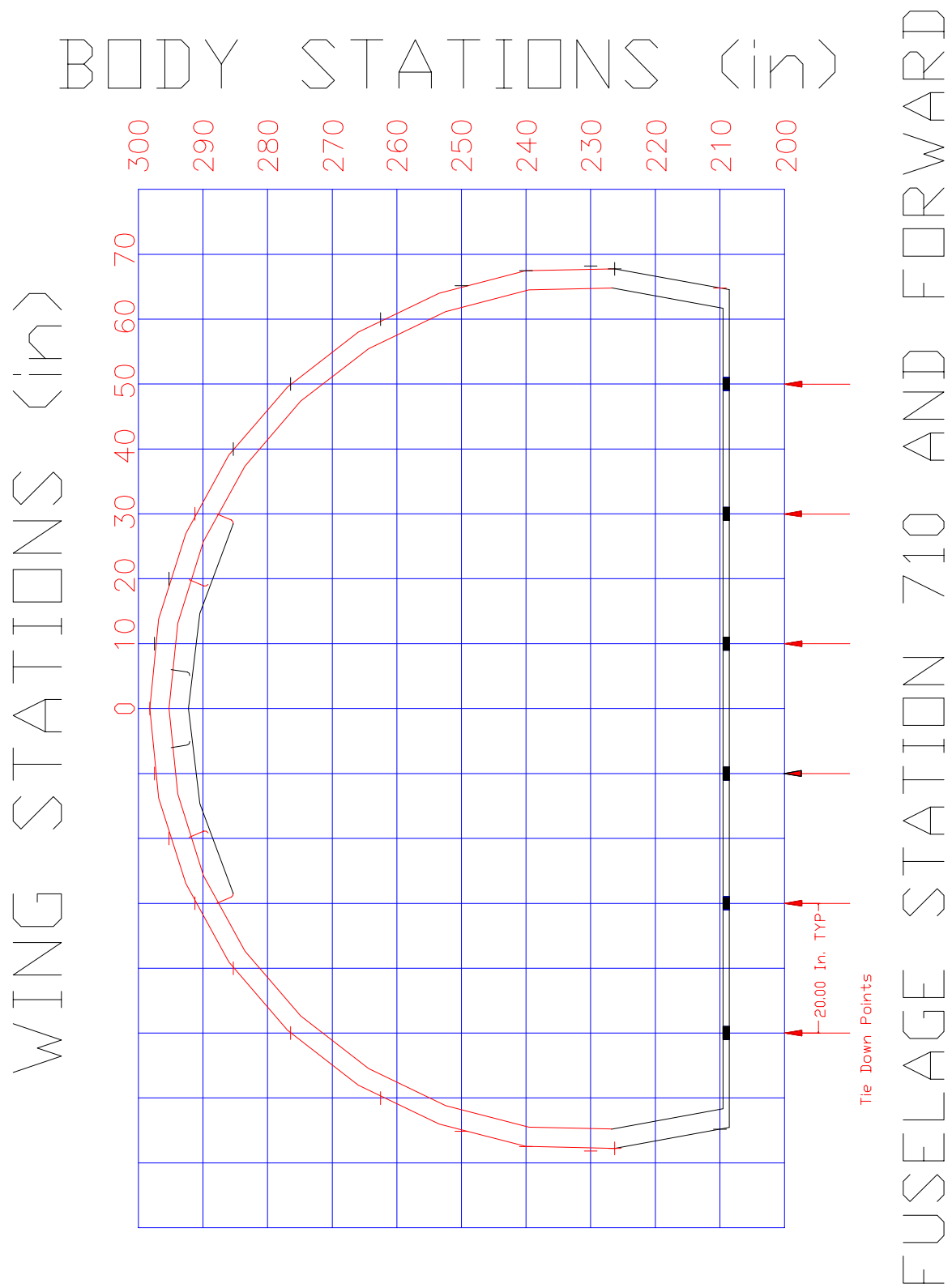


Figure 8: Cross-Section of Fuselage Station 710 and Fwd

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 33 of 165

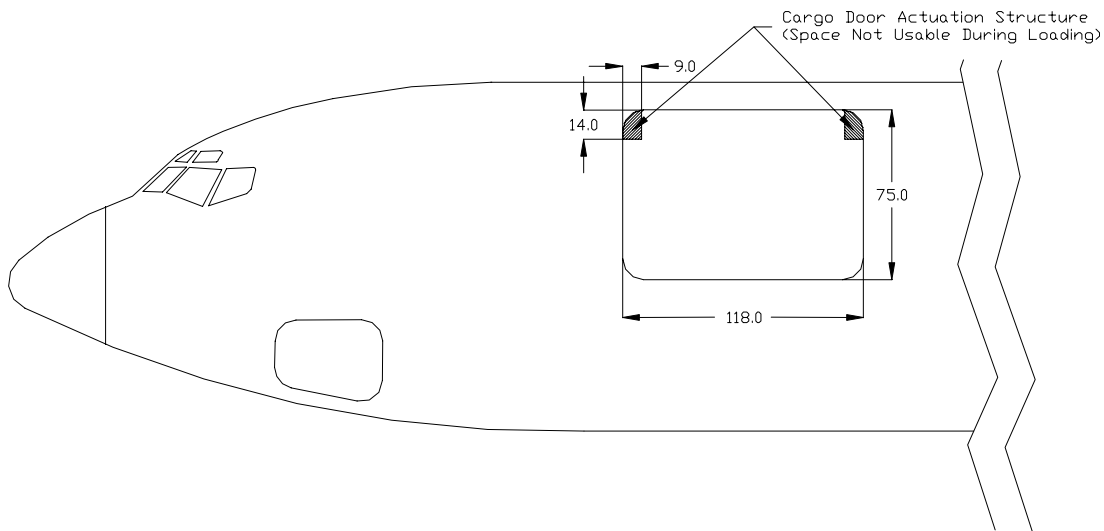


Figure 9: Cargo Door Dimensions in Inches



Figure 10 : Picture of Cargo Door Operations

3.1.3 Cabin Provisions

The aircraft is equipped with 23 seats aft of the test section. Emergency oxygen devices, life preservers, life rafts, first-aid equipment, and other emergency equipment are provided on board the aircraft. The interior walls of the cabin are covered with foam padding for the protection of personnel and equipment.

Verify that this is the correct version before use.

3.1.4 Electrical Power and Interface

Four types of electrical power are available, as shown in Table 1. The total current draw of all experiments shall not exceed the rating listed for each bus. The 115 VAC is distributed into two buses (A and B buss). Each experiment will be allotted a portion of the power budget at the time the aircraft is loaded. Special arrangements can be made for experiments with unusually high power requirements.

Table 1 : Total Electrical Test Power

Power Type	Total Current Rating
28 Volts DC	100 Amps
115 Volt AC, 400 Hz, Three Phase	50 Amps / Phase (from each of two sources)
115 Volt AC, 400 Hz, Single Phase	~ 50 Amps / Phase
115 Volt AC, 60 Hz, Single Phase	110 Amps

Aircraft electrical power is distributed via five power distribution panels. These panels are located along the lower sidewall of the test cabin at fuselage stations 460, 650, 770, 990, and 1090. A mechanical drawing of a power distribution panel is shown in Figure 6.4. The following sections will explain the mechanical interface to each type of electrical power.

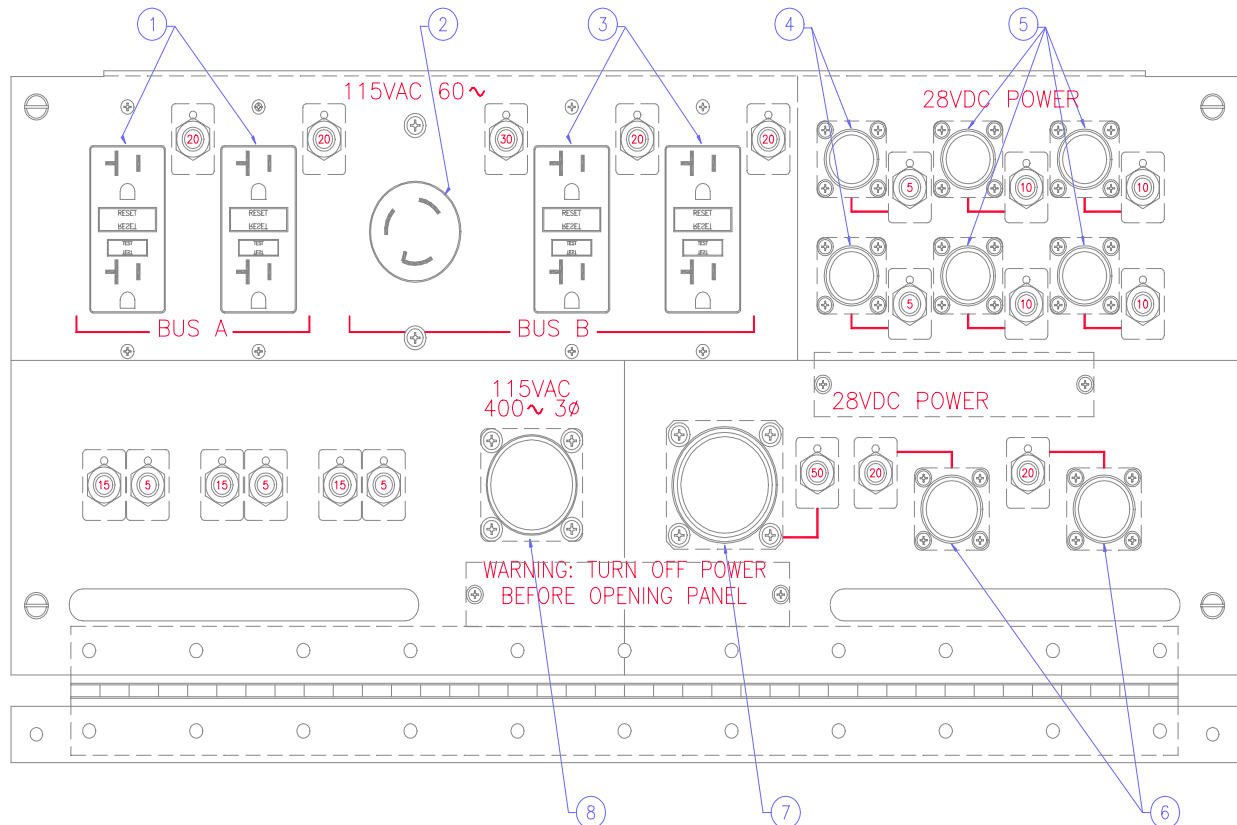


Figure 11 : Power Distribution Panel

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 35 of 165

115 VAC, 60 Hz

115 Volts AC power at 60 Hz is provided by drawing items 1, 2 and 3. The duplex GFCI outlets (drawing items 1 and 3) are common three-prong receptacles. Each duplex outlet can supply 20 Amps maximum.

The circular outlet (drawing item 2) is a common industrial 30 Amp receptacle and is compatible with Federal Standard W-C-596/90. Experimenters must provide the mating plug that is compatible with Federal Standard W-C-596/91A and NEMA L5-30P. An example experimenter plug is Hubbell TWIST-LOCK part number HBL2611 rated for 30 Amps at 125 Volts, or equivalent.

28 VDC

Each power distribution panel provides interfaces for 5, 10, 20 and 50 Amp circuits. In addition to the on-panel connectors, an expansion box will provide outlets for 15 and 25 Amp capacities. Each expansion box is powered from a 50 Amp outlet of a power distribution panel, and will be available from the Reduced Gravity Office upon request.

All 28 Volt interfaces are standard Military Specification (MS) cannon connectors.

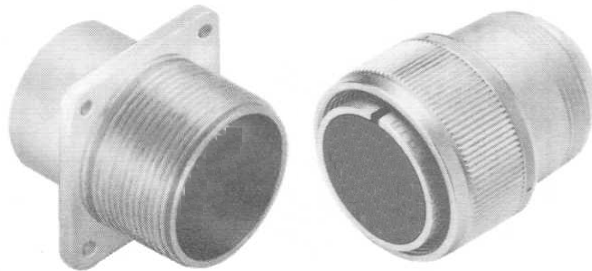


Figure 12 : MS Cannon Receptacle (Left) and Plug (Right)

Power Panel 28 VDC Interfaces

Two cannon plugs (drawing item 4) supply 28 VDC at a maximum 5 Amps.

Four cannon plugs (drawing item 5) supply 28 VDC at a maximum 10 Amps.

The mechanical connections for drawing items 4 and 5 are identical. The power distribution panel receptacle is Mil-Spec part number MS3452W14S-9S (female). Experimenters must provide the mating male plug connector, Mil-Spec part number MS3456W14S-9P (or MS3106A14S-9P). Each connector has two pins labeled Pin A (Power) and Pin B (Return). This connector is designed to accommodate 16 or 18 gauge wire. Experimenters must use wire sizes in accordance with Table 5.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 36 of 165



Figure 13 : 14S-9 Receptacle Contact Arrangement

Two cannon plugs (drawing item 6) supply 28 VDC at a maximum 20 Amps.

The mechanical connections for both 20 Amp outlets are Mil-Spec part number MS3452W16-13S (female). Experimenters must provide the mating male plug connector, Mil-Spec part number MS3456W16-13P (or MS3106A16-13P). Each connector has two pins labeled Pin A (Power) and Pin B (Return). This connector is designed to accommodate 12 or 14 gauge wire. Experimenters must use wire sizes in accordance with Table 5.

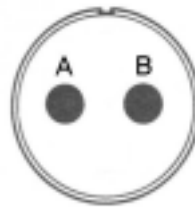


Figure 14 : 16-13S Receptacle Contact Arrangement

One cannon plug (drawing item 7) supplies 28 VDC at a maximum 50 Amps.

The power distribution panel receptacle is Mil-Spec part number MS3452W28-5S (female). Experimenters must provide the mating male plug connector, Mil-Spec part number MS3456W28-5P (or MS3106A28-5P). The connector has five pins labeled Pin A (Unused), Pin B (Power), Pin C (Unused), Pin D (Unused) and Pin E (Return). This connector is designed to accommodate 4 gauge wire on Pins B and E. Experimenters should use wire sizes in accordance with Table 5.

Note: Power cords used to reach this 50 Amp outlet should be 10 feet in length.

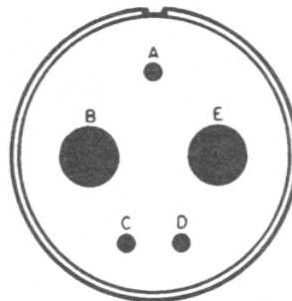


Figure 15 : 28-5 Receptacle Contact Arrangement

Expansion Box 28 VDC Interfaces

In addition to the power distribution panel connectors, an expansion box is available with outlets for 15 and 25 Amp capacities (28 VDC). Each expansion box is powered from a 50 Amp outlet of a power distribution panel, and will be available from the Reduced Gravity Office upon request.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 37 of 165

Each expansion box has two cannon plugs with a maximum 15 Amps.

The expansion box receptacles for the 15 Amp outlets are Mil-Spec part number MS3452W16-13S (female). Experimenters must provide the mating male plug connector, Mil-Spec part number MS3456W16-13P (or MS3106A16-13P). Each connector has two pins labeled Pin A (Power) and Pin B (Return). This connector is designed to accommodate 12 or 14 gauge wire. Experimenters must use wire sizes in accordance with Table 5 (at least 14 gauge wire for 15 Amps outlets).

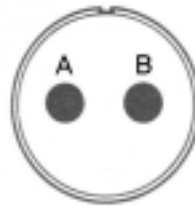


Figure 16: 16-13S Receptacle Contact Arrangement

Each expansion box has one cannon plug with a maximum 25 Amps. Please note that the 25 Amp outlet cannot be used simultaneously with both 15 Amp outlets; the 50 Amp supply of the power distribution panel cannot source 55 Amps. However, the 25 Amp outlet may be used simultaneously with one of the 15 Amp outlets.

The expansion box receptacle for the 25 Amp outlet is Mil-Spec part number MS3452W22-2S (female). Experimenters must provide the mating male plug connector, Mil-Spec part number MS3456W22-2P (or MS3106A22-2P). Each connector has three pins labeled Pin A (Power), Pin B (Return) and Pin C (unused). This connector is designed to accommodate 8 or 10 gauge wire. Experimenters must use wire sizes in accordance with Table 5.

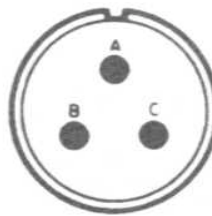


Figure 17: 22-2S Receptacle Contact Arrangement

115 VAC, 400 Hz

One cannon plug (drawing item 8) supplies raw 115 VAC aircraft power at 400 Hz. This receptacle does not have a dedicated circuit breaker on the local power distribution panel. The 400 Hz bus is breakered at 50 Amps per phase on the main aircraft power panel. The outlet is primarily intended to drive a mobile power-tower, which converts additional 400 Hz power to 60 Hz power. Researchers may use the 400 Hz outlet when it is available; however, it is the responsibility of the researchers to protect their own equipment from electrical faults. Every electrical cable from a power distribution panel should include a current limiting device on the experiment!

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 38 of 165

The power distribution panel receptacle is Mil-Spec part number MS3452W24-22S (female). Experimenters must provide the mating male plug connector, Mil-Spec part number MS3456W24-22P (or MS3106A24-22P). The connector has four pins labeled Pin A (Phase A Power), Pin B (Phase B Power), Pin C (Phase C Power) and Pin D (Neutral). This connector is designed to accommodate 8 gauge wire. Experimenters must use wire sizes in accordance with Table 5.

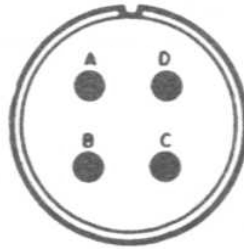


Figure 18: 24-22 Receptacle Contact Arrangement

3.1.5 Aircraft Lighting

The aircraft cabin contains thirty fluorescent photo-lights (approximately fifteen down each side-wall). These lights have been specially designed to provide sunlight-quality illumination. The bulbs are similar to those used in the film industry; they are heavy on the blue end of the color spectrum. Because of the unique design of the bulbs, daylight camera film may be used in the cabin and a flashbulb is typically not required.

A switch in the cockpit controls the intensity setting of all cabin photo lights. There are two possible intensity levels: full intensity and half intensity. The lights will be set to full intensity during the reduced gravity portion of the parabolas. During all other phases of flight (including takeoff, landing, parabola pull-up and pull-out) the lights will remain at half-intensity or off.

Each of the lights may be turned off individually. When a given fixture is turned off, it will remain off during all phase of flight regardless of the cockpit switch position.

3.1.6 High Pressure Gas System

High pressure gas systems are allowed for use on the KC-135 through compliance with all safety guidelines. All pressurized gas systems must receive approval through the pressure vessel certification procedure documented in this User's Guide (see section 5.3 Pressure Vessel Certification).

Per customer request, the RGO will provide the following high pressure gas and K-bottle handling equipment:

- 1) Nitrogen K-bottle (volume 228 ft³ at 2200 psig)
- 2) Helium K-bottle (volume 212 ft³ at 2200 psig)
- 3) Argon K-bottle (volume 248 ft³ at 2200 psig)
- 4) Breathing air K-bottle (volume 233 ft³ at 2200 psig)
- 5) K-bottle ground handling carts
- 6) In-flight, 9g rated, K-bottle mounting rack

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 39 of 165

K-bottles typically contain 215 to 250 cubic feet of gas at 2200 psig. A typical K-bottle is 9 inches in diameter and 55 inches in length. Some gas manufactures may have different letter designations for the same size gas bottle. Researchers should ensure the gas bottles they ship to the RGO are 9 inches in diameter and 55 inches in length. This is the only size gas bottle that will fit in the gas bottle racks.

K-bottles used at Ellington Field must be DOT certified.

All regulators and gauges must be in good condition, properly calibrated, and have a current certification tags. All gas systems must have appropriate sized relief valves installed at the regulators to prevent over pressurization of the gas supply line.

The RGO does not supply regulators to researchers. Any high-pressure gas equipment not owned by the RGO must be approved for use by the RGO prior to its arrival at Ellington Field (see section 6.10).

3.1.7 Overboard Vent System

An overboard vent system is available on the aircraft for the venting of most gases. No liquid can be vented through this system due to freezing which could occur at altitude. There are two vent lines, one being a multi-user line, the other a dedicated line for use by a single experiment. The multi-use vent line (1 ¼" DIA.) has two manifolds (at FS 730 and FS 980), each with five attachment points. For experiments requiring high volumetric flow rates, or to avoid chemical interaction with other experiments, a single dedicated vent line is available at FS 1100. This line (1 ¼" DIA.) has no manifolds, which maximizes the suction and flow rates for a single user.

The manifold fittings on the multi-user vent line are female (internally threaded) AN 12 fittings (3/4"); researchers must supply a male AN 12 fitting on the research equipment. (Parker Triplelok 37⁰ Flared Tube Fitting)

The dedicated vent line has a male 1¼" NPT threaded fitting. To attach directly, experimenters should fit their equipment with a 1¼" female NPT thread. The Reduced Gravity Office also has the ability to provide an AN 20 male fitting, an AN 16 male fitting, and a 1" NPT male fitting on this dedicated vent line. The researcher is responsible for providing the matching female fitting on the test equipment.

A simplified table of vent line flow rates is provided below:

Table 2 : Flow Rates

<u>Location</u>	<u>Max Flow (SCFM) 36,000'</u>	<u>Min Flow (SCFM) 26,000'</u>
Fwd Manifold	64 (total*)	61 (total*)
Aft Manifold	72 (total*)	69 (total*)
Dedicated Line	75	72

*total refers to a combination of all experiment flows at that location including all flows introduced upstream at the forward manifold.

Note: These rates apply at the manifold / fitting only.
Line losses in researcher equipment must be considered to determine flow rate at researcher's termination point.

A complete study of the volumetric flow rates through the overboard vent system has been performed and a copy is available through the Reduced Gravity Office.

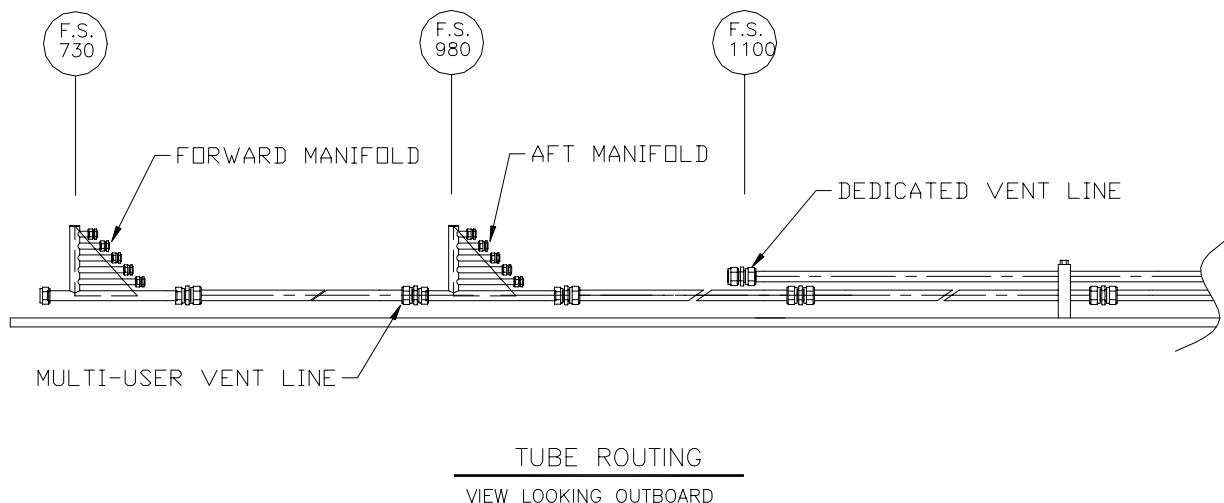


Figure 19: Overboard Vent Line

The cabin volume is = 4346 cubic feet. The cabin air exchange rate is one cabin volume per three minutes.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 41 of 165

3.1.8 Aircraft G-Load Display

There are two display panels to show the real-time g-value and the parabola count. One display is mounted on the forward bulkhead facing aft and the other is mounted on the aft bulkhead facing forward.

3.1.9 Accelerometer Signal

Accelerometer measurement signals are available from the accelerometer heads located in the aircraft cabin. Differential signals are available for G_x , G_y , and G_z accelerations. Each signal is buffered to prevent interference with aircraft systems and other researchers. All signals are bipolar (G_x and G_y are 9.8 V/g and G_z is 2.5 V/g) and vary between +/- 10V. Each signal is filtered with a normal cutoff frequency of 5 Hz. This cutoff frequency may be adjusted upon request, however this will affect the data available to the entire aircraft. Calibration data is also available upon request.

To connect to the aircraft accelerometers, researchers will need a DB-15 male connector. Pin designations are shown in Table 3 and Figure 20.

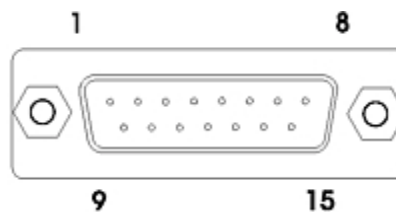


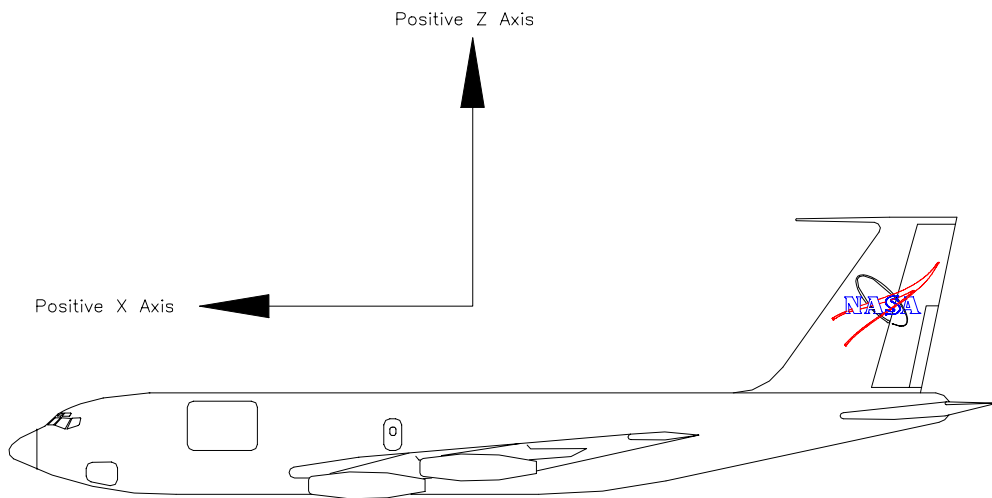
Figure 20 : DB-15 Accelerometer Data Connector

Table 3 : Accelerometer Pin Designations

Measurement	Pin Number
$G_x +$	7
$G_x -$	20
$G_y +$	21
$G_y -$	209
$G_z +$	18
$G_z -$	6

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 42 of 165



Note: The positive Y Axis is configured in the airplane to come out of the page in this view.

Figure 21 : Aircraft Acceleration Vectors

3.1.10 On-Board Tools

The Reduce Gravity Office (RGO) maintains a toolbox with a collection of hand tools sufficient to install most test packages in the aircraft. These tools are marked to show RGO ownership, are accompanied by an inventory sheet, and are inventoried daily. The toolbox and all tools are removed prior to flight. No tools are provided during flight. See Section 5.10 for a description of allowed user tools.

3.2 Photographic and Videographic Support

PHOTOGRAPHIC SUPPORT

NASA JSC photographers provide photographic support as required, for the purpose of test documentation or analysis. NASA photographic services may be arranged by including a request in the Test Equipment Data Package submitted prior to flight. Photographic support includes:

- Camera, lights, and other photographic equipment
- Expendable supplies (film, etc.)
- Image Processing and finishing (printing & writing of CD-ROM's)
- Viewing and analysis facilities

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 43 of 165

Four categories of photographic services are available:

A. Still Photography--Documentary

Documentary still photography is performed using high-resolution digital cameras. Customers can view the still images immediately after the flight. Selected images from the week's flight will be placed on the Internet for viewing, downloading or printing by the customer.

Digital 8" x 10" color prints or CD-ROM's will be available in limited quantities based on customer requests and approval from the Reduced Gravity Office.

The standard package will provide the researcher with digital images that will be available on the Internet at www.zerog.jsc.nasa.gov.

B. Still Photography--Scientific

The photographers utilize special equipment for scientific or public relations photography as requested by the user. Hasselblad medium format and Nikon 35mm cameras can be equipped to handle a variety of photographic situations.

C. Motion Picture--Documentary

Documentary motion pictures are filmed in 16mm format, either with or without synchronous sound. The JSC Photography Group is able to cover a large range of documentary situations, from simple "available-light" situations to "multiple light" set-ups.

NASA/JSC does not provide processing and prints of 16mm motion picture film.

D. Motion Picture--Instrumentation (Scientific)

Motion picture photographic instrumentation captures information, which may not be accessible, due to high speed or other factors, to the human visual system or to other instrumentation.

The JSC Photography Group uses high speed or time-lapse motion picture cameras for most instrumentation applications. These cameras provide the required compression or expansion of time so that experimental data can be recorded in a form, which is readily accessible.

The photographers are available (usually in Building 8 at JSC) to set viewing times, arrange viewing facilities or provide other assistance in analyzing the photographic data.

TELEVISION SUPPORT

NASA JSC television personnel provide support, as required, for the purpose of test documentation or analysis. Users may arrange for television imaging-capture support by including a request for NASA television service in the Test Equipment Data Package.

Television support personnel and equipment for each flight is based on particular test requirements. Equipment can include:

- (MiniDV, H-8MM, VHS, and SVHS) video recorders/camcorders)
- Video tape stock for required equipment
- Battery and AC operated color monitors for in-flight viewing

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 44 of 165

S-band downlink is now available at an additional cost to requesting researchers. Also, at present, capability for single video channel, single downlink and UHF voice uplink is available. Interested researchers must contact the Reduced Gravity Office for cost and scheduling information. Researchers planning to use the S-band downlink must contact the Reduced Gravity Office at least **six weeks** prior to flight to find out the availability of the S-band downlink. This is due to shuttle and international space station requirements the S-band downlink capability is not always available for KC-135 operations. Other television capabilities are also available, and are described in the following paragraphs:

A. Documentation

Television coverage for documentation purposes can be provided in any of the formats indicated above if requested well in advance of flight. Generally, existing light levels are adequate to support television documentation. Additional battery operated lights are available upon advance request.

B. Instrumentation or Scientific

Television imaging of specific instruments or experiment processes, not easily discernible by the human eye, (can be captured in) standard speed color video with slow-motion playback later.

C. Video Copies

Original camera videotape is kept on file in the Reduced Gravity Office with the user receiving one copy. With advanced notice, copies of the videotape can be made over night, if necessary. All other requests for copies of videos, the researcher must fill out the video request form (Appendix G) and email to the Reduced Gravity Office. Windowed copies (with the time code printed in the picture) can be generated (if the original tape is mastered to a higher format with time code capabilities.)

D. Special Services

In-flight recordings can be prearranged for viewing after the flight at the Reduced Gravity Office.

Full viewing facilities are also available at the Imagery Services Branch facilities in Building 8 at JSC. Editing capabilities also exist at JSC, and arrangements for such support should be made well in advance.

With advance arrangement, video, still prints (5 x 7 inch color prints) can be acquired after the flight through the Imagery Services group.

Special requirements for each flight, such as: wide angle lenses, specially mounted cameras on test objects, or multiple television cameras at different viewing angles, can be accommodated if arranged well in advance.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 45 of 165

3.3 Ground Facilities

This section describes the NASA ground facilities that are provided to KC-135 researchers by the Aircraft Operations Division.



Figure 22 : Picture of Ground Facilities

3.3.1 Reduced Gravity Office

Building 993 at Ellington Field provides visiting researchers with a 1,760 square foot high bay work area. This air-conditioned workspace is available for test equipment buildup and checkout. The high bay is equipped with 5-foot, 7-foot, and 10-foot workbenches for researcher use. Available electrical power includes 115 VAC, 60 Hz, 20 Amp; 115 VAC, 3 phase, 20 Amp, 400 HZ; 28 VDC, 20 Amp. Access to the work area includes two 12' X 12' roll-up doors. The building also has an adjacent conference room containing computers, telephones, a VCR and 8 mm video equipment, and video monitors.

NOTE: Building 993 does not have a vent hood for mixing of chemical inside the building. The mixing of chemicals must to be done outside of the building to ensure proper ventilation.



Figure 23 : Picture of Building 993 High Bay Work Area

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 46 of 165

3.3.2 Computers, Network Access, Printers, and Phones

The computers and the network access are provided by the RGO for OFFICIAL business ONLY. Phones are provided in the conference room. All long distance calls must be made collect or third party. Incoming calls or faxes for the researcher should use the following numbers:

Main Office: 281-244-9874
Conference Room: 281-244-9005
Fax: 281-244-9500

3.3.3 Normal Duty Hours

The Reduced Gravity Office operates Monday through Friday from 7:30 am to 4:00 pm. Researcher access to High Bay is limited to these hours unless prearranged with the Reduced Gravity Office. Access to the aircraft is 7:30 am to 4:00 pm during flight days.

3.3.4 Security

Access to Building 993 is controlled. The building is locked after normal duty hours; however, personal valuables should not be left unattended. Researchers are responsible for providing additional security, if required. All non-NASA badged individuals must obtain a temporary security badge prior to entering any JSC facility, including Ellington Field. Temporary badges are available from the Security Office in Building 110, on-site at JSC or with prior arrangement at guard post 18 at Ellington Field. See section 4.3.4 for more detail concerning security badging of personnel (U.S citizen and foreign nationals).

3.3.5 Equipment and Material Storage

Very limited storage space is available in Building 993, Requests for space must be prearranged with the Reduced Gravity Office. RGO personnel will dispose of all equipment left in Building 993 after a flight week. All chemicals will be stored in the chemical storage locker located in the High Bay of Building 993. Any chemical stored in this locker shall be clearly marked with the name of the researcher, the date it was placed in the locker and the experiment title. There are labels on the top of the chemical storage locker, for researcher use. MSDS paperwork given to RGO personnel for filing in a 3-ring binder located on top of the chemical storage locker. It is the responsibility of the researcher to notify RGO personnel when a chemical is removed after completion of an experiment.

NOTE: Any mixing of chemicals must be done outside of building 993 since the building is not equipped with an approved vent hood for chemical mixing.

3.3.6 Cryogenic Storage and Supply System

A cryogenic storage/supply system is available to provide a source of breathing air or nitrogen. The cryogenic system has a 1/2-inch standard AN fitting with a variety of available adapters. Contact the Reduced Gravity Office **six weeks** prior to flight to address any needs in this category.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 47 of 165

3.3.7 Shipping and Receiving

It is the responsibility of the researcher to arrange for the shipment of his or her research hardware to and from Ellington Field. The address for shipping research hardware is:

Reduced Gravity Office
Building 993
Ellington Field
Houston, Texas 77034
Phone Number (281) 244-9874

Arrange for your shipment to be delivered to the Reduced Gravity Office during normal business hours (7:30 am to 4:00 pm, Monday thru Friday). It is not the responsibility of the Reduced Gravity Office to pay for the shipment of research hardware. Prior to the completion of a flight week, the researcher shall make the necessary arrangements for the return shipment of research hardware. The RETURN-shipping label will show the following:

Ship To: (researcher company, school, or NASA center)

Ship From: (researcher company, school, or NASA center)

NOTE: The RGO is a pickup location ONLY. It must **NOT** be named as the SHIP FROM location on any shipping documents.



Figure 24 : Picture of Building 993 High-Bay Crane

3.3.8 Crane and Scale

Building 993 is equipped with an overhead crane that spans the distance between the two overhead doors. It has a capacity of 2,000 pounds. The maximum distance from the floor to the crane hook on the crane is 97 inches. Only certified JSC or Ellington Field personnel shall operate the crane!

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 48 of 165

3.3.9 Forklift

Forklifts are available for the unloading and loading of research equipment. The forklift is equipped with a loading platform for ease of operation when moving multiple pieces of equipment. This loading platform has a ramp on the front that enables research equipment with wheels to be rolled on and off the platform. Only certified JSC or Ellington personnel shall operate the forklift!

3.3.10 Ground Tools

The high bay of Building 993 provides a complete toolbox for researcher use while at the Reduced Gravity Office. This toolbox is shadowed to enable ease of inventory. Prior to flight, this toolbox and all tools assigned to the KC-135 aircraft will be inventoried. The High Bay facility also includes a 20-gallon air compressor, shop vacuum, bench vice, and cordless drills for researcher use.

3.3.11 Loading Assistance Tools

Loading assistance tools are available for researcher use, including:

- High Lift Truck
- Lift Platform (for the forklift)
- J-Bars
- Roller Pipe (schedule 40 PVC)
- Lifting Straps
- Lifting Pipe
- Furniture Dolly (24" x 44")

It is the responsibility of the researcher to ensure that their research hardware has been designed with the proper handholds, lifting bars, and wheels (if required) to allow for safe and easy loading and unloading of the aircraft.



Figure 25 : Picture of High Lift Truck

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 49 of 165

3.4 Flight Medicine

3.4.1 Motion Sickness Medication

Some researchers aboard the KC-135 aircraft experience motion sickness during the flight. The percentage of those with this condition is about 60%. Symptoms include pallor, increased perspiration, nausea and vomiting. In an attempt to avoid this syndrome, various medications have been used for many years but no one medicine has been perfect in preventing this condition. *Taking* the medication does not guarantee one won't become ill and, conversely, *not taking* the medication does not mean one will automatically become ill. Each individual must decide for him/herself what to do. It is not mandatory to take any medication. If a researcher wishes, NASA will provide some medication to him or her for each flight. Arrangements can be made through the Reduced Gravity Office to have passengers pick up the medication prior to flight. Researchers taking **any** sort of medication should consult with the NASA physicians associated with the flight **prior to boarding** the aircraft (preferably 24 hours prior). If a passenger is taking any sort of medication for some other condition, he or she should talk it over with the NASA physician if they plan to take the anti-motion sickness medicines offered because of possible drug interactions and possible adverse reactions. This caveat includes over-the-counter medications and "pills and potions" from a health-food source or nutrition center. Medications provided by NASA usually wear off in six to eight hours after they are ingested, but in some individuals the effects will wear off a little sooner or somewhat later (i.e., 10 to 12 hrs. later). Almost 100% of the time, all effects are gone by the evening of the flight or certainly by the next morning. We have never had a really serious reaction to medication taken for KC-135 flights. Some researchers have elected to take various "preventatives" on their own (antihistamines, copper bracelets, Meclizine, Dramamine and Ginger). It is **imperative** for the researcher to discuss this matter with one of the NASA physicians **prior to flight**.

3.4.2 Medical Facilities

If a medical problem arises that cannot be resolved by the medical officer assigned to the flight, other medical facilities are available in the local area. Some of these are:

- 1) Kelsey-Seybold Clinic (occupational/industrial facility) at JSC in building 8.
- 2) Christus St. John Hospital in Nassau Bay, Texas (directly across the street from JSC).
- 3) Clear Lake Regional Medical Center (on Texas Highway 3 between Ellington Field and JSC – about 4 miles from the airport).

In addition, there are other hospitals within 10 miles of JSC and hundreds of medical specialists in the same area.

NASA medical personnel (flight surgeons flying on the KC-135) will assist any researcher who needs more medical care.

3.4.3 Flight Surgeon Crew Duties

On most (but not all) flights of the KC-135 aircraft, a NASA medical officer will be aboard. The Lead Test Director of the Reduced Gravity Office decides when a qualified doctor is necessary. When there is no medical officer aboard, consultation with one of the NASA

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 50 of 165

physicians will be quickly established via telephone. Most NASA physicians reside at JSC and may be contacted by telephone or pager. In addition, a telephone consultation may be established with one of the physicians at the Kelsey-Seybold Clinic at JSC. The Clinic is open Monday through Friday between 7:30 a.m. and 5:00 p.m.

If a NASA doctor is aboard, he/she has specific duties. These are helping researchers or crew who may be ill or injured. He/she will be monitoring all researchers during the entire flight and cannot be asked to help with experiments or take photos/videos for researchers. Physicians aboard the aircraft are directly responsible for the health and safety of all concerned and all take this responsibility very seriously.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 51 of 165

4 USER REQUIREMENTS

This section will cover topics such as how to get a test request processed, human research protocol, medical requirements, physiological requirements, badging, and funding requirements.

4.1 Test Request Procedure

Requesting flight approval is a three step procedure:

- 1) Feasibility of Flying Inquiry
- 2) Formal Test Request (Approval Questionnaire)
- 3) Initial Test Request

Feasibility of Flying Inquiry

Contact the Reduced Gravity Office to discuss the feasibility of flying an experiment, to establish tentative dates, and to answer any specific questions.

Reduced Gravity Office,
Building 993
Ellington Field
Houston, Texas 77034
Phone 281-244-9874 Fax 281-244-9500
E-Mail: zerogl@jsc.nasa.gov

If you are working through one of the experiment coordinators (i.e. GRC, MSFC or JSC (S&LSD) contact them for scheduling information and specific details. This should occur a least **nine months** prior to flight.

Formal Test Request

The Formal Test Request (Approval Questionnaire) must be completed by the researcher or project manager (See Appendix A), this must be accomplished **six months** prior to flight.

All researchers or project managers must fill out the Experiment Questionnaire prior to scheduling their experiment to fly on the KC-135. This will ensure that only valid experiments will be considered for flight. The Chief Scientist or Chief Engineer of the requesting organization must sign all questionnaires.

The Formal Test Request (Approval Questionnaire) will be sent to the Reduced Gravity Office and to the Experiment Coordinator (if working with one). This request is valid for 2 years from the date signed.

Initial Test Request

The Initial Test Request should be submitted as soon as a flight requirement is confirmed. To ensure time constraints can be met, the request should be submitted no less than **three months** prior to the desired flight date.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 52 of 165

One copy of an Initial Test Request should be submitted to the Reduced Gravity Office and one copy should be sent to the Experiment Coordinator (if working with one). The Initial Test Request should contain general information describing the following:

- 1) Test objectives
- 2) Desired schedule (exact flight dates will be determined later)
- 3) Brief description of the test and associated test equipment
- 4) Number of test personnel required for flight and a description of the requirement for each individual's presence
- 5) Special support required or constraints, including security classification of project, if applicable
- 6) Preliminary Hazard Analysis identifying hazards and controls (any format is acceptable)
- 7) Names, addresses, and phone numbers of contacts

A representative of the JSC Institutional Review Board (IRB) will screen all initial test requests to determine if they require involvement of the JSC IRB. The researcher and the Reduced Gravity Office will be notified of the representative's decision.

The Reduced Gravity Office will work with the individual Experiment Coordinators to establish experiment manifests for individual flight weeks. The schedule priority is set on a first-come-first-serve basis. Experiments may be given higher priority because they have an immediate need or requirements to NASA. Legitimate researcher time constraints will be taken into account on a case-by-case basis.

4.2 Human Research Protocol

Researchers who plan experiments involving human test subjects, animals, or biological tests must obtain approval from the JSC Institutional Review Board (IRB). Reference JSC-20483, "JSC Institutional Review Board: Guidelines for Investigators Proposing Human Research for Space Flight and Related Investigations" for details on the IRB process.

Twenty copies of a completed Human Research Master Protocol (see Appendix E) must be submitted to the JSC IRB at least **six weeks** prior to the proposed flight date. This protocol must include the equipment safety certification, which is described in the following section, and applicable signed consent forms from each subject (see Appendix F). In addition to equipment safety certification, letter(s) of approval(s) from other IRBs and/or Institutional Animal Care Use Committees (IACUC) are required. All signed NASA/JSC Human Research Informed Consent forms must include a layman's summary of the experiment.

The JSC IRB meets at least once a month with additional meetings scheduled at the call of the Chair. Documentation as outlined in Appendix E should be submitted to:

JSC Institutional Review Board
Mail Code SA
Lyndon B. Johnson Space Center
Houston, Texas 77058

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 53 of 165



Figure 26: Picture of Researchers in the Altitude Chamber

4.3 Test Personnel Requirements

This section describes requirements that must be met for a researcher to fly on the KC-135.

4.3.1 Medical Requirements

Flight personnel are classified in two categories; Category I and Category II.

Category I personnel (Air Force Class III Flight Physical) are:

Pilots, Astronauts, Payload Specialist, AOD Aircrew, Suited Subjects, Photographers, KC-135 Test Directors, Flight Engineers, Aircraft Crew Chiefs, Medical Officers and any test subject involved in a flight requiring Level I or Level II medical coverage as mandated by the IRB. This physical is required once a year.

Category II personnel (KC-135 Examination) are:

Pressure Suit Engineer / Technicians, Test Safety Officer, KC-135 Researchers / Investigators, Research Assistants, Test Observers, Chamber Directors / Operators / Conductors, Students involved in NASA sponsored programs, News Media representatives. Test subjects not involved with Level I or Level II type experiments and any other personnel not included in the mandatory USAF Class III physical category and not mentioned in this group. This physical is required once every 3 years.

All Category II personnel with a demonstrated necessity to participate in reduced gravity flight must provide the results of a KC-135 Examination or equivalent FAA Third Class Aviation Physical. This exam must be reported on JSC Form 8500 or FAA Form 8500-8

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 54 of 165

(see Appendix C), and **dated within the previous three years**. Additionally, all test personnel must meet height and weight standards set forth in Appendix C.

The examining physician **MUST** be certified as an FAA Medical Examiner or a designated Flight Surgeon.

Costs for physical exams are the sole responsibility of the individual.

All medical questions posed by examiners should be directed to the Physiological Training Officer at (281) 792-5724. The Chief of Aircraft Operations reserves the right to refer any KC-135 manifested person to the JSC Medical Office for a medical determination of a person's fitness for flight. **The Chief of Medical Sciences Division at JSC has the final authority on whether or not a person is physically qualified to fly on the KC-135 Reduced Gravity Aircraft.**

Category I personnel must have successfully completed an Air Force Class III flight physical within the previous twelve months.

Requirements for medical certification of crewmembers and human test subjects will be met by successful completion an annual NASA flight physical.

Note: Failure to submit the required documentation for each person on time will preclude that person from flying!

4.3.2 Physiological Training Requirements

All personnel with a demonstrated necessity to participate in reduced gravity flight must have received physiological training **within the last three years**. Physiological training will include, appropriate classroom instruction and an altitude chamber hypoxia demonstration. See Appendix D for more details. Requirements for physiological training may be obtained from:

NASA Johnson Space Center
Physiological Training Officer
Mail Code SD27
Houston, TX 77058
Or call Mike Fox at 281-792-5724

There is no cost for physiological training. The only costs an individual will be required to pay are travel costs to and from Johnson Space Center or to a DOD (Air Force or Navy) facility.

A NASA employee must schedule individuals for physiological training. Those researchers working with an Experiment Coordinator must contact them to make arrangements for physiological training.

NASA employees will not need any additional badging for physiological training at the Sonny Carter Training Facility. All others must meet the badging requirements documented in paragraph 4.3.4.

Note: Failure to submit the required documentation will preclude those individuals from flying!

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 55 of 165

4.3.3 Medical and Physiological Documentation

Individuals who have received a physical at a location other than Johnson Space Center and received physiological training at a DOD (Air Force or Navy) or FAA facility, a copy of the physical exam results (JSC Form 8500 or FAA Form 8500-8) and the physiological training record for each person must be received by the Physiological Training Officer at Johnson Space Center **at least four weeks prior to flight**.

Send or FAX your completed physical and physiological training record to:

NASA Johnson Space Center
Physiological Training Officer
Mail Code SD27
Houston, TX 77058

Or

FAX to Mr. Mike Fox at 281-792-5731 (Office phone number is 281-792-5724)

4.3.4 Badging Requirements

All individuals working and visiting the Johnson Space Center, Aircraft Operations Division at Ellington Field and the Sonny Carter Training Facility must display the appropriate access badge. This section will discuss the badging requirements.

U.S. Citizens

All research personnel (flying or supporting flight operations) will be required to have the appropriate badge during their stay at JSC (Ellington Field). A NASA JSC employee must make each request for a badge. Badge request can be made through the Reduced Gravity Office or through the JSC office sponsoring the research.

It is the responsibility of the Experiment Coordinators (at GRC, MSFC and JSC), the project manager, or the principle investigator to provide badge request information to the appropriate office. This information shall be provided to the appropriate JSC office three weeks prior to visit.

For U.S. citizens, the following information is required to complete the JSC Form 1470:

Name

Organization (Company / University)

Citizenship

Dates of visit

Reasons for visit

Upon arrival at JSC or Ellington Field, the researcher will pick up their badge at the badging office in building 110 at JSC. The office hours are 6:00 a.m. to 10:00 p.m. daily (including Saturday and Sunday). With prior arrangements, U.S. citizens can pick their badges up at Post 18 at Ellington Field.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 56 of 165

Permanent Resident Aliens (“Green Card”)

Permanent Resident Non-U.S. citizens who have a Permanent Resident Alien Card (“Green Card”) are treated the same as a U.S. citizen. The only difference is when a Permanent Resident Alien arrives at JSC and picks up their badge, they must have their (original) Resident Alien Card (“Green Card”) with them.

Foreign Nationals

Foreign national visitors to JSC / Ellington Field must fill out either JSC Form 473a or 473b. Those individuals who hold citizenship from any country appearing on the List of Designated Areas must complete JSC Form 473 b. This also includes those individuals who hold dual citizenship from a country on the List of Designated Areas. NASA Headquarters must approve all JSC Form 473b.

All other foreign nationals must fill out the JSC Form 473a.

All Foreign Nationals must be badged according to building access. The specific areas that may be visited must be designated (i.e. Hangar 990 or Building 993, Building 276 etc.); you cannot just list Ellington Field. While at JSC and Ellington Field all foreign nationals must be escorted. Foreign nationals will not have access to any NASA computer systems while on site.

U.S. citizens working for a company or corporation headquartered outside the United States will be treated as foreign national and must also complete a JSC Form 473a or 473b (same procedure as citizens of another country). Individuals in this category are listed as "foreign representatives."

JSC Form 473a (NASA / JSC Badge Request Form): See Appendix J

Those individuals whose country of citizenship is NOT on the Designated Area List must fill out the JSC Form 473a. Either the Reduced Gravity Office or the JSC office sponsoring the research must receive this form **six weeks** prior to the visit. Director of Flight Crew Operations Directorate or the director of the office sponsoring the research, the JSC Export Control Office, must sign the JSC Form 473a. The Security office at JSC will approve the visit.

JSC Form 473b (NASA / JSC Badge Form for Foreign National Visitors / Employee From Designated Areas): See Appendix K

Those individuals whose country of citizenship is ON the Designated Areas List must fill out the JSC Form 473b. Either the Reduced Gravity Office or the JSC office sponsoring the research must receive this form **six weeks** prior to the visit. Director of Flight Crew Operations Directorate or the director of the office sponsoring the research, the JSC Export Control Office, must sign the JSC Form 473b. The JSC Form 473b must then be sent to NASA Headquarters for final approval. Headquarters requires 30 days to process the JSC Form 473b.

Contact the Reduced Gravity Office if you have any questions as to whether your country of origin is listed on the Designated Area List.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 57 of 165

The JSC Forms 473a or 473b form should be completely filled out and e-mailed to the Reduced Gravity Office, when possible.

Email address: zerogl@jsc.nasa.gov

If e-mail is not possible, then the JSC Form 473a or 473b shall be mailed or faxed to the Reduced Gravity Office at:

Reduced Gravity Office
Building 993, M.C. CC43
Ellington Field
Houston, Texas 77034
FAX number (281) 244-9500

When a JSC office other than the Reduced Gravity Office sponsors an experiment, experimenters will need to contact the sponsor office and send the JSC Forms 473a or 473b to them for processing.

All foreign nationals must go to building 110 at JSC to pick up their badges. The Badging Office's hours of operation are 6:00 a.m. to 10:00 p.m. daily (including Saturday and Sunday). The individual shall have with them their current passport, visa, and driver license. All foreign nationals must have a NASA escort while at JSC / Ellington Field.

4.3.5 Visitors

All visitors to the Reduced Gravity Office (Building 993) shall have the appropriate visitors badge. Contact the Reduced Gravity Office at least three weeks prior to the visit to ensure that badges will be available.

U.S. citizens will be issued Escort Required Visitor Badges (ERVVB) during their visit.

Foreign nationals will need to follow the procedures documented in paragraph 0.

4.3.6 Mishap Form

All personnel flying on NASA aircraft must submit mishap Notification Forms. This form contains the information necessary for contacting family members, or individuals of choice, in the event of an aircraft incident. All researchers must fill out the Mishap Notification Forms prior to their first flight on the KC-135. The completed forms will be kept on file in the Reduced Gravity Office during the current flight week.

4.3.7 KC-135 Safety Training

All personnel who fly on the KC-135 Reduced Gravity aircraft must watch the KC-135 Safety video. This video must be seen at least once every six months. The video explains the use and operation of safety equipment located on the KC-135 and how to egress the aircraft in the case of an emergency.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 58 of 165

4.3.8 Accident and Life Insurance Notification

All manifested KC-135 Reduced Gravity personnel must be aware that the Johnson Space Center does not operate the KC-135 Reduced Gravity Aircraft as a regularly scheduled common carrier. Most life and accident insurance policies cover only persons who fly on regularly scheduled airlines and do not cover persons involved in a research aircraft accident. Therefore, some life and accident policies may not cover a KC-135 Reduced Gravity Aircraft accident. Any person manifested to board the KC-135 should determine, before boarding, whether his or her life and/or accident insurance provide coverage under such conditions.

4.4 Funding

The Reduced Gravity Program is a cost-reimbursable program. All research or engineering development projects that fly on the KC-135 Reduced Gravity Aircraft must be funded by NASA through research grants, direct transfer of funds between the NASA center conducting the research or JSC Engineering/Science Division, and the Flight Crew Operations Directorate (FCOD). Researchers with other U.S. government agencies must make arrangements with the Reduced Gravity Office prior to their flight for the transfer of funds between NASA and the other U.S. government agency. Foreign government space agencies requesting flight time on the KC-135 must have a Memorandum of Understanding (MOU) with NASA Headquarters prior to flight.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 59 of 165

4.5 Timeline

This timeline has been designed to assist researchers in the timely submittal of required documentation.

9 months

Make initial inquiry about the feasibility of flying an experiment on the KC-135

(See Paragraph 4.1)

6 months

Submit a Formal Test Request (Approval Questionnaire - Appendix A) to an Experiment Coordinator and the Reduced Gravity Office. Approval Questionnaires must be resubmitted every two years. (See Paragraph 4.1)

3 months

Submit initial Test Request (See Paragraph 4.1)

6 weeks

Submit Test Equipment Data Package (See Paragraph 6)

Submit Institutional Review Board Requirements (See Paragraph 4.2)

Submit Photographic and Video support and "S" Band Downlink requirements as part of TEDP (See Paragraph 6.18)

Submit Badging Request for foreign nationals (JSC form 473a and 473a - See Paragraph 0)

Submit Gas (K-Bottle) requirements (Breathing Air, Nitrogen, Argon, Helium - See Paragraph 3.3.6)

4 weeks

Submit test personnel data (medical, physiological; See Paragraph 4.3.3) and names of flyers to the Reduced Gravity Office.

3 weeks

Submit badging request for all U.S citizens (See Paragraph 0)

4 days

Research hardware arrives at the Reduced Gravity Office at Ellington Field

1 day

All research hardware goes through the Test Readiness Review (See Paragraph 2.6)

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 60 of 165



Figure 27: Sonoluminescence in Space (Glynn Holt – Boston University)

5 TEST DESIGN REQUIREMENTS

The following chapter provides a detailed description of test equipment design specifications that must be met before test equipment is approved for flight on the KC-135. It is imperative that all sections are reviewed before making any design decisions. Be sure to retain all documentation throughout the design process so that it may be presented later in the flight approval process. The factors of safety presented in this section are the absolute minimum required. It is encouraged that steps be taken to exceed the established factors of safety when practical.

5.1 Test Equipment Structural Design Requirements

KC-135 test equipment must comply with the following structural design specifications and provide documented proof of compliance **six weeks** prior to flight via submission of the Test Equipment Data Package (See Section 6):

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 61 of 165

1) G-Load Specifications

- a) All test equipment (i.e. fasteners, individual components, frames, and full assemblies) must be designed to withstand the following g-loads in takeoff and landing configurations.
 - i) Forward (eyeballs out): 9 g's
 - ii) Aft (eyeballs in): 3 g's
 - iii) Down (eyeballs down): 6 g's
 - iv) Lateral (eyeballs left/right): 2 g's
 - v) Up (eyeballs up): 2 g's
- b) Structures are to be analyzed using Free Body Diagrams (FBDs) with load vectors applied at accurate centers of gravity (CG). Material yield strengths are to be used as the maximum allowable throughout all design calculations.

2) Floor Attachment Hardware

- a) The Reduced Gravity Office (RGO) will provide all of the hardware required for fastening the test equipment to the floor of the KC-135. Table 4 details the RGO provided hardware to be utilized with test equipment:

Table 4 : Floor Attachment Hardware

Floor Hardware Description	Hardware Dimensions	Yield Tensile Strength (lbs)	Single Shear Strength (lbs)
NAS 184-6 Steel Studs	3/8" DIA – Lengths Vary	5,000 lbs	5,000 lbs
AN-6 Steel Bolts	3/8" DIA – Lengths Vary	5,000 lbs	5,000 lbs
2.0" Wide Cargo Strap	Lengths Vary	5000 lbs	N/A
1.5" Wide Cargo Strap	Lengths Vary	1000 lbs	N/A
1.0" Wide Cargo Strap	Lengths Vary	400 lbs	N/A
*Floor Spacers	Heights Vary	N/A	N/A

- b) Aluminum floor spacers are used to direct equipment weight loads directly into the aircraft floor beams (bypassing the floor foam), and to load studs or bolts in single shear (under 9 g forward loads) at each floor attachment location. They are not utilized when cargo straps are used to fasten equipment to the floor. The maximum amount of weight allowed to rest on one spacer in a 1 g environment is 200 lbs/spacer (i.e. 1200 lbs/spacer is allowed in a 6 g down load case).

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 62 of 165

- c) Test equipment fastened to the floor using studs or bolts must possess a frame or base-plate that matches the floor attachment grid in the KC-135 test cabin. Floor attachment holes in the experiment base plate must be centered on a 20" square pattern with holes drilled using 1/2" diameters. See Figure 28.

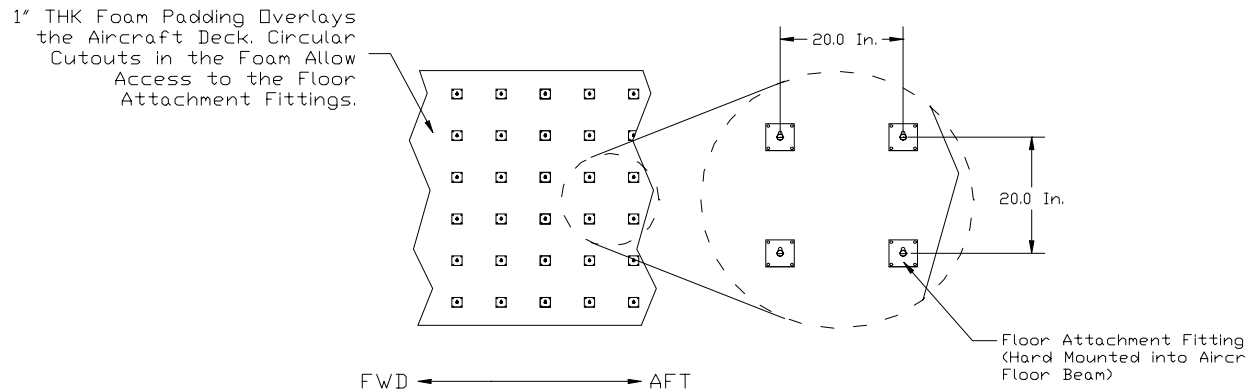


Figure 28: Test Cabin Floor Schematic

- d) Cargo straps may be used to tie-down equipment to the test cabin floor. Straps are provided by the RGO (See Figure 5.1 for tensile strength limits of cargo straps). When using cargo straps, it is essential to design load-bearing beams and/or handles with sufficient load capacities to withstand g-load specifications. See Figure 29 for a cargo strap attachment schematic.

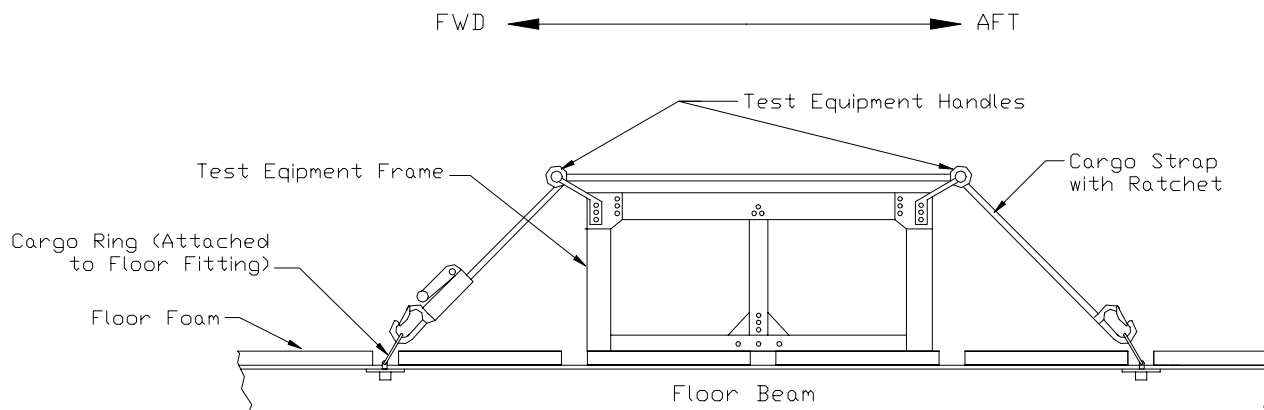


Figure 29: Cargo Strap Schematic

- e) Test equipment resting on the floor padding instead of spacers (typically the case when cargo straps are used) must not exceed the allowable floor loading of 200 lbs/ft² (this is for the in-flight load case, not ground loading) without proper floor shoring. The RGO will implement any floor shoring required.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 63 of 165

- f) Spacers will accompany the use of studs or bolts to fasten test equipment to the floor (they are not used with cargo straps). Spacers do not resist forward, lateral, or upward loads, but do resist downward loads. 200 lbs of test equipment weight is allowed to rest on each spacer in the 1 g environment. For example, if an experiment weighs 780 lbs. (in 1 g), at least four spacers must be utilized in order not to exceed the allowable spacer/compressive load. See Figure 30 for a standard stud/spacer floor attachment schematic.

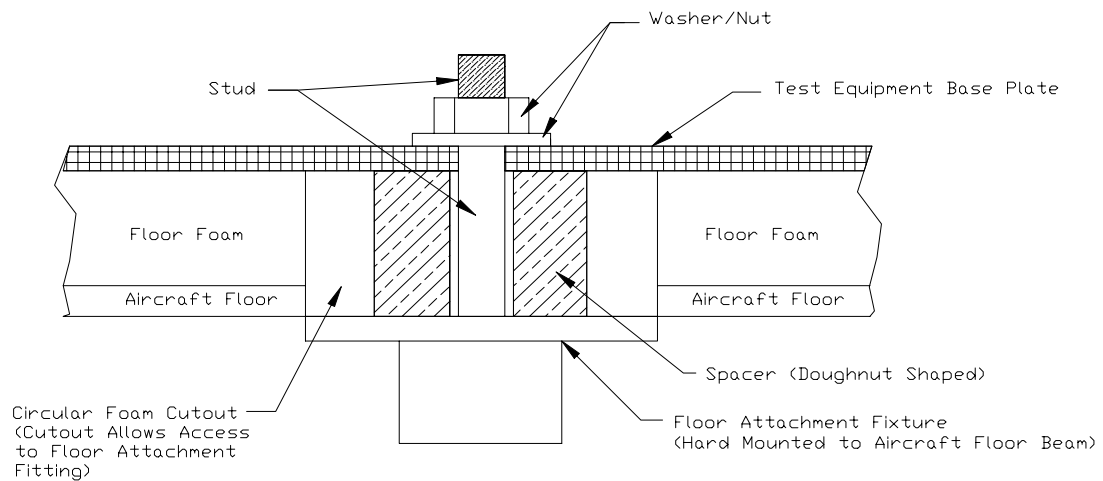


Figure 30 : Stud/Spacer Floor Attachment Assembly

- g) If test equipment is over 10 feet in length (length being along the forward/aft axis of the fuselage), a hinge must be integrated into the structure of the test equipment to allow for fuselage bending without increased stress in the aircraft frame.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 64 of 165



Figure 31 : Picture of Fully Loaded Aircraft

5.2 Aircraft Loading

Hardware proposed for flight on the KC-135 must take into consideration provisions for safe and efficient aircraft loading operations (these guidelines do not apply for in-flight floor load requirements). Researcher hardware and proposed ground loading operations must comply with the following requirements:

- 1) All hardware must be designed to fit through the cargo door and into the test cabin with enough clearance to avoid the risk of damaging aircraft structure.
- 2) A forklift is available at Ellington Field for lifting hardware up to the cargo door. This is typically done through utilization of the lifting pallet. A High Lift truck is also available to load equipment into the aircraft.
- 3) Handles and/or lifting bars (this does not include existent structural ledges on hardware) must be implemented in the hardware design if: a) the hardware weighs more than 50 pounds, and b) the proposed loading method involves human manipulation. There should be enough handles available so that any one person carrying the hardware does not lift more than 50 pounds.
- 4) For heavier assemblies, pneumatic casters, six inches in diameter or more, are recommended for hardware loading operations both on the ground and in the aircraft test cabin. Caster loads must not exceed 350 lbs/wheel. Casters must be removed from the hardware, and taken off of the aircraft before flight. Handles shall be available on the equipment for manipulation procedures after casters are removed.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 65 of 165

- 5) Hardware base plates with an aircraft floor footprint greater than 1.5 square feet must not exceed 1600 lbs/ft² of floor loading during ground loading operations. Hardware base plates with an aircraft floor footprint of less than 1.5 square feet must not exceed 350 lbs/in². Caster loads must not exceed 350 pounds per wheel.
- 6) If allowable floor load must be exceeded, proper floor shoring procedures must be integrated with ground loading operations. Please notify the Reduced Gravity Office via the Test Equipment Data Package if this is necessary. All shoring procedures must be designed and implemented through the Reduced Gravity Office.

5.3 Pressure/Vacuum System Requirements

All pressure/vacuum systems proposed for flight and/or ground use, must comply with Johnson Space Center Document JHB 1710.13B. To comply with JHB 1710.13B, all system categorization, design, test and inspection, and certification instructions described in this section of the User's Guide must be strictly followed. In this document, a pressure system is defined as *equipment used, in-flight or on the ground, to contain gas and/or liquid above or below ambient pressure*. Therefore, vacuum systems are implied to fall under the definition of a "pressure system."

5.3.1 Classification Requirements

All pressure systems proposed for flight and/or ground support must fall into one of the five categories listed below. Review the category descriptions to determine which category best describes the experiment's pressure system.

Category A

- 1) **Level 1:** These pressure systems conform to consensus codes and standards (ASME, DOT, ANSI, etc.) and may or may not have a code stamp. Non-stamped pressure systems are termed "code equivalent." Pressure systems are automatically categorized as a *Category A system* if pressures of 150 psig or greater exist in the system, and/or the system contains a toxic, corrosive, explosive, and/or flammable fluid.
- 2) **Level 2:** These pressure systems, because of pressure requirements, fabrication techniques, or material selection, do not fall within the scope of the applicable codes and standards, yet are designed in accordance with code formulas, documented stress values, and code safety factors. Pressure systems are automatically categorized as a *Category A system* if pressures of 150 psig or greater exist in the system, and/or the system contains a toxic, corrosive, explosive, and/or flammable fluid.

Category B

Category B pressure systems do not fall within the scope of this document, and do not apply to KC-135 research equipment.

Category C

Category C pressure systems have a combination of pressure contained volume and service fluid such that the maximum potential energy, if released, would not cause serious injury to personnel or significant damage to facilities.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 66 of 165

Category D

Category D pressure systems are isolated, protected, contained, or restrained in such a manner that the maximum catastrophic failure would not be harmful to personnel, facilities, or equipment.

Category E

Category E pressure systems are inherently low in energy, or possess a national record of operation without serious incident:

- 1) Water systems (150 psig or less and at 110° F or less)
- 2) Commercially manufactured heating, ventilation and air conditioning (HVAC) systems used expressly for their intended purpose.
- 3) Commercially manufactured refrigerators and freezers used expressly for their intended purpose.

5.3.2 Pressure System Design Requirements

All pressure systems proposed for flight and/or ground support must comply with the following design requirements. Be aware that the aircraft is pressurized at roughly 8000 ft. pressure altitude during parabolic maneuvers. Design calculations for flight hardware should assume the worst-case scenario (i.e. rapid cabin decompression at the peak flight altitude) and allow factors of safety to be sufficient if the cabin pressure rapidly falls to 35,000 ft. pressure altitude.

Category A Design Requirements

A maximum allowable working pressure (MAWP) must be designated for all pressure systems. Systems must be designed so that they never exceed this pressure under normal operating procedures. The system MAWP should not exceed the manufacturer specified MAWP of any individual component or line.

All hardware must be designed to satisfy a factor of safety of no less than 4 when MAWP is compared to material ultimate strengths, and no less than 2.0 when MAWP is compared to material yield strengths. All design calculations must be documented. Lower factors of safety may be used only with the approval the Reduced Gravity Office. See the example equation below:

$$\text{Factor of Safety} = \frac{\sigma_{ultimate}(psi)}{\sigma_{MAWP}(psi)} \geq 4$$

All mobile/portable pressure and vacuum vessels that are used on the KC-135 and at Ellington Field shall be designed to address the requirements of Code of Federal Regulations (CFR) 49 or Section VIII of the ASME Boiler and Pressure Vessel Code. Any mobile/portable pressure vessels that are to leave JSC property shall be designed according to the requirements stated in CFR 49.

At a minimum, all pressure systems must be designed for the most severe condition of coincident pressure and temperature expected in operation. MAWP values should not be below this pressure. Please also consider the following in determining a pressure system design:

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 67 of 165

- 1) Weight of the pressure system.
- 2) Static reactions from weight of attached equipment.
- 3) Cyclic and dynamic reactions caused by pressure or thermal variations, flow-induced vibrations, or attached equipment and mechanical loadings.
- 4) Impact reactions such as those due to fluid shock.
- 5) Temperature gradients and thermal expansion.

Use materials that possess properly documented physical properties (i.e. strength, corrosion resistance, thermal expansion coefficients, etc.) by industry standard sources (i.e. Military Handbook 5). Consider the properties of a material carefully before utilizing it in a pressure system design.

The temperature used in the design of the pressure system shall not be less than the mean metal temperature (through the thickness) expected under operating conditions.

All Category A pressure systems shall be equipped with properly sized pressure relief devices. They shall be set to function at a maximum of 10% above the MAWP to prevent over-pressurization and possible catastrophic explosion due to component failure (failed regulator, runaway heater, etc.), ambient temperature influences, rapid cabin depressurization/over-pressurization, and/or external sources of heat (i.e. fire). These devices shall be:

- 1) Sized to prevent pressure from rising more than 10% above MAWP.
- 2) Properly calibrated to certify settings and function.
- 3) Selected on the basis of their intended service.
- 4) Installed on the pressure system in such a way that they are readily accessible for inspection.

All welds in a pressure system must be designed in accordance with the American National Standards Institute (ANSI) Document B31 and/or the ASME Boiler and Pressure Vessel Code, as applicable. Complete drawings of the welded assembly shall be generated using weld symbols that meet the requirements of the American Welding Society (AWS) Document A2.4.

All piping systems must have adequate structural support to prevent the development of excessive piping stresses, leakage at joints, excessive loads on connected equipment, and resonance due to flow.

Gauges shall be sized to indicate a minimum of 150 percent to a maximum of 200 percent of the pressure system's MAWP for all pressure gauges incorporating a mechanical, dial indicating, bourdon tube, bellows or diaphragm type mechanism. Gauges must have a pressure relief mechanism internal to the gauge, and must be properly calibrated before use.

Category B Design Requirements

Category B pressure systems do not fall within the scope of this document, and do not apply to KC-135 research equipment.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 68 of 165

Category C Design Requirements

Category C pressure systems are to be designed using good engineering practices. A maximum allowable working pressure (MAWP) must be designated for all Category C pressure systems. Systems should be designed to never exceed this pressure under normal operating procedures. The system MAWP should not exceed the manufacturer specified MAWP of any individual component or line. Professionally calibrated pressure relief valves and gauges are required on all Category C pressure systems. All hardware must be designed to satisfy a safety factor of no less than 4 when MAWP is compared to material ultimate strengths, and no less than 2.0 when MAWP is compared to material yield strengths. All design calculations must be documented. Lower safety factors may be used only with the approval the Reduced Gravity Office. See the example equation below:

$$\text{Pressure Vessel Factor of Safety} = \frac{\sigma_{ultimate}(psi)}{\sigma_{MAWP}(psi)} \geq 4$$

Category D Design Requirements

Category D pressure systems are to be designed using good engineering practices. A maximum allowable working pressure (MAWP) must be designated for all Category D pressure systems. Systems should be designed to never exceed this pressure under normal operating procedures. The system MAWP should not exceed the manufacturer specified MAWP of any individual component or line. They shall be isolated, protected, constrained, or restrained in such a manner so that catastrophic failure would not be harmful to personnel, facilities, or equipment. Professionally calibrated pressure relief valves and gauges are required on all Category D pressure systems. Category D pressure system housings must be designed to satisfy a safety factor of no less than 4 in the event of being exposed to 1.25 times the maximum allowable working pressure of the system it is containing. Housing design calculations must be documented. See the example equation below:

$$\text{Housing Factor of Safety} = \frac{\sigma_{ultimate}(psi)}{1.25\sigma_{MAWP}(psi)} \geq 4$$

Category E Design Requirements

Category E pressure systems shall be designed and installed using industry accepted engineering and fabrication practices.

5.3.3 Pressure System Test and Inspection Requirements

All pressure systems must comply with the test and inspection criteria listed below. Understand that all pressure systems (gauge calibration tags, relief valve tags, etc.) will be inspected and expected to operate at the Test Readiness Review. Have all pressure system documents readily available at the TRR. All pressure systems, regardless of classification, past flight history, and configuration, must be tested and inspected in its current configuration before each visit to Ellington Field. ASME, ANSI, and DOT components need not be tested if their certification tag is visible and current.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 69 of 165

Category A Test and Inspection Requirements

Pressure systems must be proof pressure tested by qualified pressure systems specialists (i.e. certified technician, professional mechanical engineer, etc.). This can be accomplished through hydrostatic tests (i.e. pressurize system using water) up to 150% MAWP, or pneumostatic tests (i.e. pressurize system using gas) up to 125% MAWP. Hydrostatic testing is the preferred method. Proof pressure testing can be performed on the entire pressure system assembly, or on each individual component, piping included. Document the inspection by including a brief test description, test date, technician/engineer involved (with signature), test procedure, and results. Remember to tag all equipment that has been calibrated and/or inspected with pertinent test information such as calibration dates, type of test (hydrostatic, pneumostatic), relief valve setting, etc. Professionally tagged ASME, DOT, and/or ANSI pressure vessels need not be pressure tested.

All relief valves must be initially tested and tagged by qualified pressure system specialists (i.e. certified technician, professional engineer, etc.) to verify relief valves have been tested and set to operate at proper pressure levels. Relief valves built into control devices (i.e. regulator relief valves) do not require certification when the control device and associated piping is adequately protected from over-pressurization by design of other relief devices. All gauges must be properly calibrated and tagged with pertinent inspection information by qualified pressure system specialists (i.e. certified technicians, professional engineers, etc.). A technical inspection and system operation test will be performed on all Category A pressure/vacuum systems at the Test Readiness Review (TRR). Have all pressure/vacuum system documents readily available at the TRR. Have all gauges and pressure relief valves calibrated, tested, and tagged before arriving at the TRR to expedite the certification process.

Category B Test and Inspection Requirements

Category B pressure systems do not fall within the scope of this document, and do not apply to KC-135 research equipment.

Category C Test and Inspection Requirements

All Category C pressure/vacuum systems must meet the same Test and Inspection Requirements as Category A pressure systems (see Category A Test and Inspection Requirements).

Category D Test and Inspection Requirements

A technical inspection and system operation test will be performed on all Category D pressure/vacuum systems at the Test Readiness Review (TRR). Have all pressure/vacuum system documents, housing design calculations, and component calibration tags readily available at the TRR.

Category E Test and Inspection Requirements

A technical inspection and system operation test will be performed on all Category E pressure/vacuum systems at the Test Readiness Review (TRR). Have all pressure system documents readily available at the TRR.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 70 of 165

5.4 Electrical

All electrical wiring and interconnect cabling must be fabricated and installed in accordance with the current versions of the JSC Safety Manual and the National Electrical Code.

Each experiment must have emergency shutdown capabilities. The preferred shutdown method is a single “kill switch” in an easily accessible location. If an experiment requires multiple “kill switches” they should be co-located in one area of the experiment.

Researchers should be prepared to demonstrate their experiment’s emergency shutdown capability at the Test Readiness Review (TRR).

In the event of electrical power loss (expected or unexpected), all experiments must fail to a safe configuration. There will be a brief interruption of electrical power during engine startup and momentary interruptions of electrical power may occur during flight. Although infrequent, brief power interruptions may disrupt certain sensitive instruments. Test equipment should incorporate protection devices (such as a UPS) to prevent data loss.

All electrical experiments should meet reasonable requirements for electro-magnetic compatibility (EMC) and susceptibility. Any experiment determined to be interfering with other experiments or aircraft instrumentation systems will be terminated.

Experiments that require aircraft power must provide an electrical cable to reach a power distribution panel. This cable will be referred to as a “power cord” for the remainder of this document. All power cords should be 20 feet in length and have a descriptive tag secured to the end. The tag will clearly list the voltage and maximum current required (not maximum current available) from the aircraft outlet. Labeling each power cord helps the flight crew balance the electrical load on the aircraft. Appropriately rated extension cords may be used as power cords.

Typically, an experiment platform will include a power-strip device to eliminate multiple power cords from the platform. When a power-strip is used, the combined current of all devices shall not exceed the capacity of the aircraft source outlet. Multiple power cords may be used on an experiment when load balancing is desired.

All experiment wiring, including power cords, must be adequately restrained and clamped. Normal aircraft vibration, high humidity, handling, and higher than one-g loads should be considered in connector and wiring selection. All exposed power leads and electrical contacts must be covered to protect personnel as well as the equipment itself. Electrical insulation should be protected against abrasion and chaffing which could expose bare contacts. Any exposed metal surfaces must be adequately grounded to prevent electrical shock.

Each part of an experiment’s electrical system should be labeled. Each cable, connection and component should have a unique identifier that is clearly visible. High-voltage devices must be marked with warning labels.

It is the responsibility of the researchers to protect their own experiments from electrical faults. In addition to existing aircraft circuit protection, each experiment must be self-protected with an incorporated circuit breaker or other current-limiting device. Though not yet required, it is strongly recommended that each electrical component have a dedicated current-limiting device as well. The limiting value of each device should be carefully

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 71 of 165

chosen with the maximum current of the protected components in mind. As a minimum, 115 Volt AC systems should be protected with an appropriately rated surge protector.

When selecting circuit breaker values, the sum of the *maximum* device currents cannot exceed the rated current of the power source (or circuit breaker value). Ideally, each circuit should be designed so that the total *nominal* current of all devices does not exceed 80% of the rated supply current. Experimenters must use wire sizes and circuit breakers in accordance with Table 5.

All batteries used must be of the dry cell or gel-cell type. Liquid electrolyte batteries are not allowed on the aircraft!

Sizing of electrical wiring is critical. All experiment cables, including power cords, must be of the appropriate size (or gauge) for the intended current draw across the wire. The NASA Reduced Gravity Office requires all experiments to comply with the wire sizing guidelines of MIL-PRF-6106K and SAE AS50881 (which replaces MIL-W-5088L). A summary of those guidelines is provided in Table 5.

Table 5 : Minimum Wire Gauges

Maximum Current	Minimum Wire Gauge
5 A	18 Gauge
10 A	16
15 A	14
20 A	12
25 A	10
30 A	8
50 A	4

The insulation of each wire must clearly show a manufacturer printed wire gauge label. All wires should be made of copper, and have a wire temperature rating of at least 60° C. Higher rated wire such as 105° C is strongly encouraged!

The minimum wire size guidelines have been created using mathematical formulas from SAE document AS50881 (which has replaced MIL-W-5088L). The calculations assume the worst-case (most conservative) operating conditions for electrical wire with a temperature rating of 60° C. Experimenters are encouraged to use wire with greater temperature ratings; however the maximum current ratings from Table 3 must be followed to prevent wires that are too hot to touch.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 72 of 165



Figure 32 : Picture of Free-Float Experiment

5.5 Free Float

Perturbations of the airplane can cause small accelerations during a zero-g maneuver. If a more precise zero-g is required, the test package can be allowed to free-float inside the cabin to prevent contact with the walls, ceiling, or floor of the aircraft. The maximum allowable free-float package weight is 400lbs. To provide the optimum free-float time, the package to be floated should be as light and compact as possible. If an umbilical is used between the floating package and tied-down support equipment, it should be at least 20 feet long to allow the floating package to freely drift. Handles, the length of the longitudinal axis of the package in its floating configuration, should be mounted using 1-inch tubing near the top and bottom of the package.

5.6 Overboard Vent

Requests for use of the overboard vent system shall be made in the Test Equipment Data Package. It is required that the chemical composition and quantity of the vented gas be entirely known and completely understood by the experimenter. It is the responsibility of the experimenter to inform the Reduced Gravity Office via the Test Equipment Data Package concerning all possible hazards associated with the vent gas, including (but not limited to) the possibility of freeze-up, blockage, ignition, corrosion, and chemical reaction with other agents that could be introduced by another experiment.

The manifold fittings on the multi-user vent line are female (internally threaded) AN 12 fittings (3/4"); therefore, researchers need to supply a male AN 12 fitting on the research equipment.

The dedicated vent line has a male 1-1/4" NPT threaded fitting. To attach directly, experimenters should fit their equipment with a 1-1/4" female NPT thread. The Reduced Gravity Office also has the ability to provide an AN 20 male fitting, an AN 16 male fitting,

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 73 of 165

and a 1" NPT male fitting on this dedicated vent line. The researcher is responsible for providing the matching female fitting on the test equipment.

The multi-user vent line will be employed for standard venting operations. The Reduced Gravity Office shall be informed via the Test Equipment Data Package if the dedicated vent line is required for an experiment. Since only one experiment per flight can hook-up to the dedicated line, this request must be clearly stated in the Overboard Vent Requirements section to avoid scheduling conflicts with other researchers requesting its use.

Table 6 : Overboard Vent Flow Rates

<u>Location</u>	<u>Max Flow (SCFM) 36,000'</u>	<u>Min Flow (SCFM) 26,000'</u>
Fwd Manifold	64 (total*)	61 (total*)
Aft Manifold	72 (total*)	69 (total*)
Dedicated Line	75	72

*total refers to a combination of all experiment flows at that location including all flows introduced upstream at the forward manifold.

Note: These rates apply at the manifold / fitting only. Line losses in researcher equipment must be considered to determine flow rate at researcher's termination point.

A complete study of the volumetric flow rates through the overboard vent system has been conducted and a copy is available through the Reduced Gravity Office.

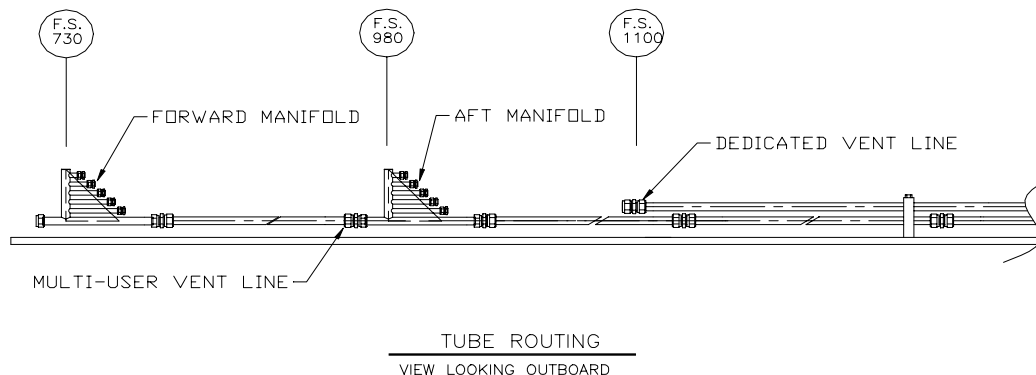


Figure 33 : Overboard Vent Line

The cabin volume is = 4346 cubic feet. The cabin air exchange rate is one cabin volume per three minutes.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 74 of 165

5.7 Laser

The following requirements are to be used as guidelines for the use of all classes of lasers proposed for flight on the KC-135. The Johnson Space Center (JSC) Radiation Safety Committee has adopted the latest revision of ANSI Z136.1 (American National Standard for Safe Use of Lasers) as the guide for approving lasers and/or laser systems proposed for use in facilities and aircraft under the administrative control of JSC.

5.7.1 Class Designation

All lasers or laser systems must be categorized in a class according to the class definitions listed below. It is recommended that the minimum class laser be used that will accomplish the payload objective. Class definitions are as follows:

- 1) **Class 1:** Lasers or laser systems that do not, under normal operating conditions, pose any hazard whatsoever.
- 2) **Class 2a:** Low-power visible lasers or laser systems that are not intended for prolonged viewing, and under normal operating conditions will not produce a hazard if the beam is viewed directly for periods not exceeding 1000 seconds.
- 3) **Class 2:** Low-power visible lasers or laser systems which, because of the normal human aversion response (i.e. blinking, eye movement, etc.), do not normally present a hazard, but may present some potential for hazard if viewed directly for extended periods of time.
- 4) **Class 3a:** Lasers or laser systems having CAUTION labels that normally would not injure the eye if viewed for only momentary periods (within the aversion period) with the unaided eye, but may present greater hazard if viewed using collecting optics. Lasers that have DANGER labels and are capable of exceeding permissible exposure levels for the eye in 0.25s should also be considered as a part of this class.
- 5) **Class 3b:** Lasers or laser systems that can produce a hazard if viewed directly. This includes intra-beam viewing of specular reflections.
- 6) **Class 4:** Lasers or laser systems that produce a hazard not only from direct or specular reflections, but can also produce hazardous diffuse reflections. Such lasers may also induce skin hazards as well as fire hazards.

5.7.2 Protective Housings

A suitable, protective housing shall be provided for all classes of lasers or laser systems. These housings or enclosures shall have interlock switches to prevent operation of the laser when the housing or enclosure is removed. Exceptions will require review by the Reduced Gravity Office **six weeks** prior to the flight.

5.7.3 Equipment Labels

All lasers or laser systems shall have appropriate warning labels with an appropriate cautionary statement. The label shall be affixed to a conspicuous place on the laser housing or control panel. Such labels should be placed on both the housing and control panel if separated by more than three feet or by abrupt change in normal viewing direction.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 75 of 165

5.7.4 Viewing Portals and Collecting Optics

Viewing portals and collecting optics (lenses, telescopes, microscopes, etc.), intended for viewing use on all lasers, must incorporate a means (interlocks, filters, attenuators, etc.) of maintaining a level of laser radiation at or below the Maximum Permissible Exposure (MPE) limit at all times.

5.8 Emergency Procedures

Emergency procedures for experiments must be meticulously derived and easy to accomplish. Researchers must be comprehensively knowledgeable of their experiment/hardware and be ready at all times to initiate these procedures without delay. All equipment must be designed so that in the event of test cabin power loss, rapid cabin depressurization, fluid leaks, fire, etc., there will be no chance of inducing another hazardous situation. **Emergency procedures must be placarded on equipment, using easy to understand instructions placed at a highly visible location.**

In the event of a researcher becoming incapacitated, a KC-135 Test Director should be able to safely and efficiently initiate emergency procedures to fail-safe an experiment. A single action “kill switch” is the preferred means of securing research equipment in the event of an emergency.

5.9 Hazardous Materials

If possible, avoid the use of hazardous liquids and gases, including high pressure, toxic, corrosive, explosive, and flammable materials. If such materials are required for a test, proper containment must be provided. Early contact with the Reduced Gravity Office and the JSC Safety Office for discussions on proper use and containment of proposed hazardous materials may prevent delays in getting approval for the use of such materials. If such materials are necessary, provisions for dumping and purging in flight may be required. A current MSDS must be supplied for each hazardous material.

For hazard material release calculation, the cabin volume is ≈ 4346 cubic feet. The cabin air exchange rate is one cabin volume per three minutes.

5.10 User Tools

Tools brought to Ellington and allowed on the aircraft will be kept to an absolute minimum. All tools will be stored in a proper container such as a tool bag or box. Each tool shall be marked to indicate its owner. Each container will have an inventory sheet listing all tools. Tools needed for flight shall be included during the TRR briefing for approval, and a copy of the tool inventory must be provided to a Test Director prior to each flight. Those tools exposed on research hardware will be tethered to the equipment. A Test Director must approve changes to the tool list prior to flight.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 76 of 165

5.11 Miscellaneous Guidelines

The KC-135 flight environment is one of the most unique flying experiences in the world. It is very difficult to describe the physical, zero-g sensation and even more difficult to model the operation of equipment during various g-phases of a parabola through tests on the ground. As a result of experiencing thousands of parabolas, KC-135 flight crew members have formulated the following guidelines to help make research on the KC-135 effective, enjoyable, and most importantly, safe.

- 1) Pad all hard and sharp edges that could conceivably be accessed by voluntary or involuntary operations. Foam tubing purchased at any hardware store works great to accomplish this.
- 2) The cabin pressure is maintained at roughly 8000 ft. pressure altitude during flight. Have this in mind while designing equipment.
- 3) Design equipment with the 1.8 g (approximately), pull-out phase of the parabola in mind. Be sure to address this portion of the parabola in your experiment procedures.
- 4) Use of sharp objects is strongly discouraged during flight on the KC-135 (i.e. syringe needles, pins, etc.). If the use of sharp objects is absolutely necessary, meticulous containment is required.
- 5) Any glass, cathode ray tubes (CRT's), gauges, windows, or any other object that is susceptible to shattering must be entirely contained and unexposed to the test cabin, or must have a lexan/plexiglass cover.
- 6) Lead acid batteries (i.e. car batteries) are not allowed on the KC-135.
- 7) Oil lubricated pumps are not allowed on the KC-135 due to the occurrence of oil leaks induced through reduced gravity operations. Air-cooled pumps are the preferred alternative.
- 8) An abundance of tools are available for researcher use through the Reduced Gravity Office (RGO). Do not bring your entire tool shed or expect to carry any tool that isn't absolutely necessary on the airplane. Anything that is brought on the airplane must be accurately inventoried and accounted for at all times. Requests to borrow tools should be made to the RGO only. Do not borrow tools from Ellington Field aircraft maintenance technicians.
- 9) Standard duct tape is allowed for use on research equipment. Duct tape used to attach miscellaneous articles (i.e. wire bundles, clip boards, etc.) to any part of the aircraft, must be provided by the Reduced Gravity Office. Duct tape is not certified to meet structural load requirements during take-off and landing.
- 10) Velcro is typically used to mount small equipment items (i.e. clipboards, keyboards, etc.) to the aircraft and/or hardware frame during the parabola phase of the flight (Note: the adhesive side of a Velcro strip must not be directly attached to any part of the aircraft. A strip of RGO provided duct tape must first be installed onto the aircraft (i.e. test cabin floor) before applying the Velcro adhesive on top of the duct tape.). Velcro is not certified to meet structural load requirements during takeoff and landing.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 77 of 165

- 11) Have contingency procedures ready for the operation and/or shut down of equipment in the event of one or more researchers becoming incapacitated due to motion sickness.
- 12) Know that aircraft operations can at any given moment be delayed or canceled due to maintenance operations, weather conditions, and/or many other safety issues.
- 13) Strategically locate experiment operators around the perimeter of an experiment. Do not over-crowd one specific area. Keep controls and emergency shut down switches in one localized area.
- 14) Foot straps will be provided by the Reduced Gravity Office to help anchor personnel to the floor of the aircraft test cabin.
- 15) Drinking water is available throughout the flight per request to the Flight Doctor or Test Directors. It is your responsibility to make sure that the water remains contained and accounted for at all times. Duct tape or Velcro is not allowed as an attachment means for water bottles during takeoff and landing. Food is not allowed on the aircraft at any time. Gum and candy will be provided through the Flight Crew to help counter the effects of motion sickness.
- 16) Inventory and provide proper containment for all articles (i.e. tools, water bottles, disks, everything) taken aboard the aircraft. This inventory list must be submitted to a Test Director before every flight. Minimize this list to the least amount of articles needed for ground loading and flight operations. Duffel bags and/or coolers are often cargo strapped to the test cabin floor to serve as containment vessels.
- 17) The KC-135 Test Directors will be directly involved with any free-floating of an experiment.
- 18) Wear layers of clothing (i.e. typically one sweatshirt, one T-shirt, and shorts) underneath the flight suit provided by the RGO. Cotton is the best material to wear under the flight suit, as it will insulate and absorb perspiration. Tennis shoes are the preferred type footwear. Test cabin temperatures are comfortable, but can fluctuate somewhat in-flight. Do not bring your own flight suit and do not wear jewelry. Flight suits have many pockets, and should only be used to store flight essential items that have been properly inventoried.
- 19) Personal camcorders and cameras are generally allowed on the KC-135. The Reduced Gravity Office will inform the aircraft passengers whether or not personal footage can be taken during the flight. If camcorders, cameras, tape recorders, etc. are brought on board the aircraft, they must be securely stowed during takeoff and landing, and always under the owners control during flight.
- 20) When cutting off the excess end of the tie wrap, ensure the cut end is close to the locking end of the tie wrap so there are no sharp edges exposed.
- 21) Cover all exposed electrical terminals with tape or plexiglass.
- 22) There will be no unattended operation of research equipment on the aircraft or in building 993. Someone familiar with the shut down procedures will be in attendance during any equipment operation. If an experiment is operating and no one is near the equipment, a test director **will** power the experiment down.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 78 of 165

5.12 Containment of Loose Parts and Equipment

All loose parts and equipment will be maintained in a proper container (such as a tool bag or box) during flight. These items will be kept to an absolute minimum and each item shall be marked to indicate its owner. Each container will have an inventory sheet listing all items and shall be included during the TRR briefing for approval. A copy of the inventory must be provided to a Test Director prior to each flight and any changes to the list must be approved by the Test Director prior to flight. Any loose item that cannot be contained during flight will be tethered. If any loose item is lost during flight, a Test Director must be notified immediately so that the experiment can be put into a safe mode and a search begun to locate the missing item. Once the item is located, the experiment will be allowed to resume operation.

5.13 Spill Control

Fluids approved for flight on the KC-135 must be contained in a system that is structurally sound to withstand g-loads specified in section 5.1, and any passenger interference (i.e. kicks, falls, bumps, etc.). A MSDS form must be submitted in the Test Equipment Data Package for all fluids other than water. Avoid the use of toxic, corrosive, and explosive fluids. Hardware used to contain fluid must be designed with suitable provisions for leak control to ensure a leak free system during ground and flight operations. In the event of aircraft power loss, all hardware must fail to a mode allowing for sound, fluid containment. If fluid is drained to an ambient pressure reservoir during flight operations, fluid absorption methods must be installed to eliminate the chance of leaks through loose seals. Lead acid batteries (i.e. car batteries) are not allowed on the KC-135, nor are oil-lubricated pumps. Air-cooled pumps are the preferred alternative. Boxes containing ultra-absorbent chem.-wipes are placed in the KC-135 test cabin at strategic locations; however, this does not override the design requirement of leak-proof hardware.

5.14 EMI/RFI Checks

All electrical experiments should meet reasonable requirements for electro-magnetic compatibility (EMC) and susceptibility. Any experiment determined to be interfering with other experiments or aircraft instrumentation systems will be shut down. This may occur during flight operations. Experiments may also be powered down to help troubleshoot an EMI problem.

5.15 Cleaning Equipment for Zero-G Flight

Shavings, splinters, dirt, and dust pose very different problems in a zero-g environment than they do in a one-g environment. Small particles will become airborne in zero-g and pose a health hazard (for eyes, ingestion, inhalation, etc.). For these reasons, all experimental hardware must be thoroughly cleaned prior to loading the KC-135. After cleaning the equipment in the normal upright position, turn all research hardware upside-down and vacuum, and/or blow out all material shavings created during the hardware assembly phase.

Equipment repairs performed onboard the aircraft (i.e. drilling, sanding, filing, or any other operation that may produce shavings or splinters) must be approved by a Test Director. A Test Director will inspect the research hardware upon completion.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 79 of 165

5.16 Touch Temperature for Research Hardware

Research hardware that contains heaters, furnaces or other heat producing devices shall maintain a touch temperature of no greater than 122 F (50 C). Guards or other protection measures must be employed for research hardware where the touch temperatures are greater than 122 F.

5.17 KC-135 Noise Levels

The MIT Space Systems Laboratory performed the following KC-135 Occupational Noise Exposure Evaluation on March 27, 2000.

OSHA limits for noise exposure are given in duration of exposure and for a given dBA (A-weighted) level. Allowed exposure time decreases as noise levels increase. For employees exposed to noise levels > 85 dBA over an 8-hour work period, OSHA requires some hearing monitoring and protection program. Sound levels greater than 140 dB are not permitted for any duration of exposure. OSHA noise exposure limits are given below:

Duration (hrs)	dBA
8	90
6	92
4	95
3	97
2	100
1.5	102
1.0	105
0.5	110
0.25	115

NASA KC-135 Noise Level Evaluation

To compute dBA levels for each flight condition, a microphone and data recorder were flown aboard the KC-135. This data was later analyzed. Microphone data was converted to pressure data by calibrating the microphone to a known pressure source. A pistonophone was used for this, supplying a 124 dB pressure level at 250 Hz. The microphone response was linear over the frequency range of interest, so with the known pressure level of the pistonophone (P_r), a linear relationship between microphone voltage (V_m) and measured pressure could be established. It was determined to be:

$$P_r = 6.84V_m$$

For each flight condition, the time-varying pressure data was then filtered using standard third-octave filters with no more than 6dB attenuation at $0.89f_m$ and $1.12f_m$, where f_m is the center frequency of the band in question. For each third-octave band, the power spectral density was then computed as:

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 80 of 165

$$G(f, B) = \frac{1}{T} \int_0^T p^2 dt$$

where T is the observation time and p the pressure in Pa. The band pressure level (BPL) was then computed using:

$$BPL = 10 \log \left[\frac{G(f, B)}{(2 \times 10^{-5})^2} \right]$$

where the BPL is given in dB and $(2 \times 10^{-5} \text{ Pa})$ is a reference pressure. An A-weighting filter was then applied to each frequency band and an integration over all frequency bands was performed resulting in a single dBA level.

The results of the testing are given in terms of A-weighted sound pressure levels for each condition. The flight conditions with the highest sound levels were climb out and take-off. The parabolas were the flight conditions with the lowest sound levels. KC-135 results are tabulated below for varying flight conditions. The frequency band with the highest sound level is also given:

Flight Condition	DBA	Max Freq. Band (Hz)
Calibration	128	250
Calibration 2kHz	129	250
Climb out	119	250
Take off	109	250
Level flight	105	400
Parabola 50k	94	400
Parabola 2k – 1	98	400
Parabola 2k – 2	95	400
Parabola 2k – 3	93	630
Parabola 2k – 4	92	400
Taxi	95	315
Sitting – no engines	53	160

Plots showing specific frequency band response for varying flight conditions are given on the following pages as well as a plot of the A-weighting filter used to convert to dBA levels. The MATLAB script used to compute the KC-135 data is also given.

Recommendations

It can be seen that noise levels aboard NASA's KC-135 exceed OSHA exposure limits if it is assumed that a typical KC-135 flight lasts for more than one hour. To avoid permanent hearing loss for fliers, it is recommended that hearing protection devices be used. This is especially important for individuals making frequent flights aboard the aircraft.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 81 of 165

6 TEST EQUIPMENT DATA PACKAGE REQUIREMENTS

The following chapter provides a detailed description of the documentation required in the Test Equipment Data Package. A Test Equipment Data Package must be prepared for each experiment proposed for flight on the KC-135. It must be thoroughly completed in accordance with these guidelines and submitted to the Reduced Gravity Office no later than six weeks prior to flight. All documentation requirements must be addressed and submitted in the correct format (as stated herein) before an experiment is approved for flight. It is imperative that all sections be addressed. If a section is not applicable to your experiment, do not leave it out. Instead, address the non-applicable section with a brief statement explaining why it is not applicable to your experiment, and move on to the next section. The Test Equipment Data Package requirements presented in this chapter are the absolute minimum required. These minimums should be exceeded if required to thoroughly explain an experiment.

NOTE: Any changes to an experiment which occur after the Test Equipment Data Package has been submitted will result in disqualification of the experiment for flight unless the Reduced Gravity Office has received appropriate documentation of the change and the Lead Test Director has approved the changes with a signature. The Test Equipment Data Package must follow the section-order presented below:

- 1) Cover Page
- 2) Quick Reference Sheet
- 3) Table of Contents
- 4) Flight Manifest
- 5) Experiment Background
- 6) Experiment Description
- 7) Equipment Description
- 8) Structural Analysis
- 9) Electrical Analysis
- 10) Pressure Vessel Certification
- 11) Laser Certification
- 12) Parabola Details and Crew Assistance
- 13) Free Float Requirements
- 14) Institutional Review Board (IRB)
- 15) Hazard Analysis
- 16) Tool Requirements
- 17) Photo Requirements
- 18) Aircraft Loading
- 19) Ground Support Requirements
- 20) Hazardous Material

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 82 of 165

21) Material Safety Data Sheets (MSDS)

22) Procedures

23) Bibliography

The remainder of this chapter provides detailed writing instructions for each section of the Test Equipment Data Package.

6.1 Cover Page

The cover page to the Test Equipment Data Package must contain the principal investigator's name, research organization and contact information (email address, phone number, and mailing address), the experiment's title, and the date the package was completed.

6.2 Quick Reference Data Sheet

The Quick Reference Data Sheet should be completed in the format shown on the following page and included on a dedicated page.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 83 of 165

KC-135 Quick Reference Data Sheet

Principal Investigator:

Contact Information:

Experiment Title:

Flight Date(s):

Overall Assembly Weight (lbs.):

Assembly Dimensions (L x W x H):

Equipment Orientation Requests:

Proposed Floor Mounting Strategy (Bolts/Studs or Straps):

Gas Cylinder Requests (Type and Quantity):

Overboard Vent Requests (Yes or No):

Power Requirement (Voltage and Current Required):

Free Float Experiment (Yes or No):

Flyer Names for Each Proposed Flight Day:

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 84 of 165

6.3 Table of Contents

The Table of Contents shall list the sections of the Test Equipment Data Package with corresponding page numbers. All pages of the Test Equipment Data Package shall be numbered sequentially.

6.4 Flight Manifest

The Flight Manifest section must list the names of the people flying to perform the experiment. It should include preferred days of flight, state whether or not each flyer has flown parabolas on the KC-135 before, and provide the date(s) of any previous flights.

6.5 Experiment Background

This section of the Test Equipment Data Package should describe why this experiment is being flown on the KC-135. It should be noted whether the experiment is a follow-up of a previous experiment, a preliminary step to a future experiment, or related to a space flight experiment. Technical references detailing related research should be listed here, along with the name of any supporting NASA organization or program.

6.6 Experiment Description

This section of the Test Equipment Data Package shall briefly, but thoroughly, explain the experiment and should be written so that a practicing engineer or scientist can understand the experiment. Science (or engineering) goals should be presented along with a description of the expected results. Expected or actual results for accompanying ground-based experiments should also be presented here.

6.7 Equipment Description

This section must thoroughly describe the equipment required for performing the experiment. It must include all flight and ground-based equipment including drawings and/or photographs of the equipment, sizes and weights of individual components, and the overall experiment size and weight. A proposed layout of the equipment in the aircraft (for takeoff and landing, as well as during parabolas) is also required which includes placement of restraints for the experimenters and required operators and positions around the experiment. Components of the experiment should be described in detail. Any laser, fluid, chemical, pressure vessel, and free float requirements (include fluid quantities) should be specifically listed. In addition, any component with special handling requirements or special hazards must be described in detail. All items to be taken on-board the aircraft during flight must be listed in this section, including cameras, outreach experiments, tools (see Section 6.16), personal items and mementos, etc. Any special requirements (in-flight or ground based) shall also be described here. Also in this section, please state whether or not the experiment will free float.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 85 of 165

6.8 Structural Analysis

Follow the guidelines below to meet the documentation requirements for the structural analysis section of the Test Equipment Data Package.

- 1) Submit free body diagrams (FBDs) for all g-load conditions listed in the Structural Design Requirements Section of this User's Guide (FBDs are sketches used to dimensionally locate where g-loads are applied on test equipment.). G-loads will be applied at equipment centers of gravity (CGs).
- 2) Create a table documenting individual component weights and overall assembly weight. Specify all materials used for test equipment fabrication and their respective allowable load. Specify all fasteners used, weld types, and their location on the test equipment assembly (this is best accomplished by using a table, detailed drawing/schematic, and/or digital pictures).
- 3) Submit all design calculations showing comprehensive compliance with all experiment structural design requirements on:
 - a) The attachment of components to the frame (prove all components will remain intact and attached to the experiment frame under the g-loads specified in the Structural Design Requirements Section)
 - b) The full assembly (prove the frame will withstand the g-loads specified in the Structural Design Requirements Section, induced from its own mass and those masses of the components attached to it)
 - c) The floor attachment of the experiment to the aircraft floor (see the Structural Design Requirements Section for g-loads and allowable aircraft mounting hardware)
 - d) If applicable, design calculations proving free-floated hardware can withstand 3 g's in any direction
 - e) The floor load analysis (prove that equipment will not exceed aircraft allowable floor load in-flight)
- 4) Provide a table that displays the factor of safety/margin of safety result from each structural analysis performed. Label the load case analyzed (i.e. 9g forward load), location of the analysis on the experiment assembly (i.e. laptop computer bracket attachment), and calculated factor of safety or margin of safety.
- 5) Components may be pull-tested at a component's CG using a properly calibrated tension gauge to simulate g-loads on equipment. This can be used for the structural analysis of lightweight components in determining whether or not attachment brackets can withstand structural design requirements. It is not recommended that this be performed on full assemblies. To properly document pull tests, address the following questions:
 - a) How was the test performed (include schematics if necessary)?
 - b) What test equipment was utilized and how was it calibrated?
 - c) Who performed the test and when?

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 86 of 165

6.9 Electrical Analysis

All experiments that use electrical power (including battery power) must provide an electrical analysis formatted in three parts: Schematic, Load Table and Emergency Shutdown Procedures.

6.9.1 Schematic

The analysis should provide a graphical schematic drawing that clearly details the top-level (not the inner circuitry of each component, but the interaction of each component at the box level) electrical design of the experiment. The schematic should include the following:

- 1) All wiring and electrical devices
- 2) Each power cord from an aircraft power distribution panel
- 3) Which aircraft outlets are used, and the voltage and current draw on each outlet
- 4) A unique identifier (such as a number) matching the actual label on each wire, or wire bundle
- 5) The gauge number and current carried on each wire
- 6) A current limiting device and its limiting value for each power cord (ideally, a current limiting device would be installed on each electrical component)
- 7) A master "kill switch"
- 8) The grounding method used to bond exposed metal surfaces

6.9.2 Load Tables

All experiments that use electrical power must provide a Load Table for each power source. The purpose of a Load Table is to describe the electrical power drawn from each power source and ensure that the source is not overloaded. In the interests of safety, battery powered experiments should complete a Load Table as well.

Note: Manufacturer supplied batteries used to power camcorders, laptop computers or similar devices should be described in the electrical analysis, but a Load Table is not required as long as the device is operated from the battery. A Load Table is required when an AC adapter is used to power the device.

One Load Table should be provided for each power source in an experiment. For example, if two power cords are driven by an aircraft power distribution panel, then two Load Tables should be completed. If a six-volt battery is used to power part of the experiment, a third Load Table should be completed to describe that circuit as well.

Each table should provide a description of the power source including the operating voltage and the rated current. The table must provide a detailed list of each load device and the *maximum* current draw of each device. The sum of the *maximum* device currents cannot exceed the rated current of the power source (or circuit breaker value). Ideally, each circuit should be designed so that the total *nominal* current of all devices does not exceed 80% of the rated supply current.

An example Load Table is given in Table 7. One power cord is used to run the experiment from an aircraft power distribution panel. The cord is plugged into the 115 Volt AC outlet

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 87 of 165

that is circuit breaker protected to 20 Amps on the panel. The cord has a wire gauge (size) of 12. The power source in the example (the aircraft outlet) is used to run four devices, as shown on the right hand column of the table. The total *maximum* current draw of all devices is at the bottom of the column. The total *maximum* current draw must not be greater than the rated current of the supply outlet! Again, each circuit should be designed so that the total *nominal* current of all devices does not exceed 80% of the rated supply current.

Table 7 : Example Load Table

Power Source Details		Load Analysis
Name	: Power Cord A	Widget 1 - 1 Amp
Voltage	: 115 VAC, 60 Hz	Widget 2 - 5 Amps
Wire Gauge	: 12	Widget 3 - 5 Amps
		Widget 4 - 2 Amps
Max Outlet Current: 20 Amps		Total Current Draw: 13 Amps

The analysis must describe any devices used to build a large electrical charge (such as large capacitors or wire coils). The description should provide the maximum voltage of the charge and explain how this energy will be dissipated in the experiment.

6.9.3 Electrical Kill Switch

Finally, each experiment must have emergency shutdown capabilities. A detailed description of the Electrical Shutdown Procedures must be provided in the electrical analysis. The procedures shall describe the “kill switch” incorporated into the design as well as the experiment's reaction to a power loss.

6.9.4 Loss of Electrical Power

Experiments may lose electrical power for a number of reasons. A circuit breaker on the aircraft power supply may be tripped; the experiments emergency “kill switch” may be activated; the aircrew may purposely cut all test power in the event of an in-flight emergency.

In the event of electrical power loss (expected or unexpected), all experiments must fail to a safe configuration. Researchers should be prepared to demonstrate their experiment's emergency shutdown capability at the Test Readiness Review (TRR).

6.10 Pressure/Vacuum System Documentation Requirements

All pressure/vacuum systems must comply with the documentation requirements listed below. This documentation is to be included in the Test Equipment Data Package (submitted to the Reduced Gravity Office six weeks prior to flight). All pressure/vacuum systems, regardless of past flight history and classification, must provide accurate documentation on the most current system configuration proposed for flight. All systems will be required to operate at the Test Readiness Review (TRR).

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 88 of 165

Category A Documentation Requirements:

Category A pressure/vacuum system documents must be submitted to the Reduced Gravity Office via the Test Equipment Data Package no later than six weeks prior to the scheduled flight date. Late submission of documentation will result in flight disqualification.

- 1) Provide a brief description of the pressure/vacuum system's purpose, components, fluids, fluid quantities, and operating procedures.
- 2) Provide a schematic showing the location of individual components in the system, including pressure relief devices, gauges, and K-bottles. Label each component in the schematic with a number, and utilize the sample table below for component descriptions.
- 3) As shown in Table 8, list the individual system components and their design specifications. ASME, ANSI, and DOT certified components do not need to be proof-pressure tested. For those columns that do not apply, simply place N/A (not applicable) in the appropriate box:

Table 8 : Pressure System Design Specifications

Schematic Reference #	Component Description	MAWP (psi)	Relief Valve Setting (psi)	Regulator Setting (psi)	Built By	Cert. Test / Calib. Date	Proof Test – Certified By
*1	Nitrogen K bottle	2200	N/A	N/A	ACME, Inc.	May 2, 1999	On “k” bottle DOT sticker
2	Regulator	3000	N/A	200	PDT Co.	Aug 1, 1999	AJN
3	Pressure Relief Valve	500	220	N/A	E & A Indus.	Dec 31, 1999	AJN
4	Stainless Steel Tub.	3000	N/A	N/A	M & K Products	May 15, 1999	**P - BCH
5	Reaction Chamber	***250	N/A	N/A	Organization Design	Oct 9, 1999	**H - AJN

* The number “1” identifies the component labeled “1” on the pressure/vacuum system schematic.

** The “H – AJN” indicates that a hydrostatic proof-pressure test was performed on the reaction chamber by AJN on October 9, 1999. The “P” shown for component 3 indicates a pneumo-static proof-pressure test was performed.

*** The value of 250 MAWP for the reaction chamber is the maximum allowable working pressure (MAWP) designated to that component by engineering analysis. If this component were to be operated using a higher pressure, you would decrease its factor of safety beyond a minimum of 4. Therefore, this system must never be operated at pressures above the lowest MAWP found in the table.

- 4) Provide detailed drawings of the pressure/vacuum system design. Dimensions, materials, weld joints, and fasteners must be displayed. ASME, ANSI, or DOT certified components are exempt from this requirement.
- 5) Provide design calculations with free body diagrams (FBDs) and factor of safety values. ASME, ANSI, or DOT certified components are exempt from this requirement.
- 6) Include records on system configuration changes, modifications and repairs, inspections performed, etc.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 89 of 165

- 7) All pressure/vacuum systems will be inspected and required to operate at the Test Readiness Review (TRR). They are to operate as proposed in the submitted documentation.

Category B Documentation Requirements:

Category B pressure/vacuum systems do not fall within the scope of this document, and do not apply to KC-135 research equipment.

Category C Documentation Requirements:

Category C pressure/vacuum system documents must be submitted to the Reduced Gravity Office via the Test Equipment Data Package no later than six weeks prior to the scheduled flight date. Late submission of documentation will result in flight disqualification. These systems, because of their simplistic design and small potential for damage, require, as a minimum, a general schematic of the system configuration, a table of relief valve pressure settings and component maximum allowable working pressures (MAWP), and a MAWP value for the entire system. All pressure/vacuum systems will be inspected and required to operate at the Test Readiness Review (TRR). They are to operate as proposed in the submitted documentation.

Category D Documentation Requirements:

Category D pressure/vacuum system documents must be submitted to the Reduced Gravity Office via the Test Equipment Data Package no later than six weeks prior to the scheduled flight date. Late submission of documentation will result in flight disqualification. These systems require, as a minimum, a general schematic of the system configuration, a table of relief valve pressure settings and component maximum allowable working pressures (MAWP), and a MAWP value for the entire system. Design calculations for the pressure vessel housing must also be included showing compliance with minimum factors of safety values. All pressure/vacuum systems will be inspected and required to operate at the Test Readiness Review (TRR). They are to operate as proposed in the submitted documentation.

Category E Documentation Requirements:

Category E pressure/vacuum system documents must be submitted to the Reduced Gravity Office via the Test Equipment Data Package no later than six weeks prior to the scheduled flight date. Late submission of documentation will result in flight disqualification. These systems, because of their simplistic design and small potential for damage, require, as a minimum, a general schematic of the system configuration, a table of relief valve pressure settings and component maximum allowable working pressures (MAWP), and a MAWP value for the entire system. All pressure/vacuum systems will be inspected and required to operate at the Test Readiness Review (TRR). They are to operate as proposed in the submitted documentation.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 90 of 165

6.11 Laser Certification

The following information must be documented in the laser certification section of the Test Equipment Data Package and submitted to the Reduced Gravity Office six weeks prior to the scheduled flight date.

- 1) State what class of laser is being used with your experiment.
- 2) For all lasers, submit the following information:
 - a) Laser class, type, and manufacturer.
 - b) Description of the laser's purpose.
 - c) Address when the laser will be used during the flight, and for what duration.
 - d) Describe the containment controls (i.e. describe the protective housing, interlock switches, emergency kill switch, temperature/fire control, protective eyewear, etc.).
- 3) For lasers categorized in classes 3 and 4, submit the following additional information:
 - a) Detailed description of the laser hardware
 - b) Description of the laser parameters.
 - c) Description of the operating and alignment procedures.
 - d) Description of the operators' training and experience level.
 - e) Description of the medical surveillance requirements.

6.12 Parabola Details and Crew Assistance

In this section provide all details on parabola requirements for the flight week. If the research experiment requires partial (.01, .05, .1, .16, .38, .5 etc.) g levels indicate how many of each and when during a normal parabola set of 8 to 10 you would want the partial g parabolas to occur. Keep in mind that we normally try to get 10 parabolas per set with a 2 to 3 minute break in between parabola sets. Weather conditions at altitude will dictate how many parabolas we actually get during a set. Breaks, if your experiment requires breaks other than the normal 2 to 3 minute break during the turn around, you must let us know. This will impact the number of parabolas that can be done on a given flight. The more we fly straight and level the less time we can do parabolas. Researchers must also keep in mind that you will not be the only research project on the flight and concessions must be made by everyone. The Test Directors will do their best to accommodate all the needs and request of the researchers scheduled to fly that flight, but within reason. Also, note any crew assistance that may be required, both on the ground and during flight. Such as, free floating an experiment, notification of steady zero g state, etc.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 91 of 165

6.13 Institutional Review Board

In this section of the Test Equipment Data Package, please address whether or not an IRB approval is needed for your experiment. Test developers who plan research involving human test subjects, animal test subjects, or biological tests must obtain approval from the JSC Institutional Review Board (IRB). Reference "JSC Institutional Review Board: Guidelines for Investigators Proposing Human Research for Space Flight and Related Investigations (JSC-20483), for details on the IRB process.

Twenty copies of a completed Human Research Master Protocol (see Appendix E) must be submitted to the JSC IRB at least six weeks prior to the proposed flight. This protocol must include the equipment safety certification described in the following section, and applicable signed consent forms for each subject (included in Appendix f). In addition to equipment safety certification, letter(s) of approval from other (institutional) IRBs and/or Institutional Animal Care Use Committees (IACUC) is required. All signed NASA/JSC Human Research Informed Consent forms must include a Layman's Summary of the experiment.

The JSC IRB meets at least once a month with additional meetings scheduled at the call of the Chair. Documentation as outlined in Appendix C should be submitted to:

JSC Institutional Review Board
Mail Code SA
Lyndon B. Johnson Space Center
Houston, Texas 77058

6.14 Hazard Analysis Report Guidelines

These guidelines are intended to help the test developer identify hazards in the test equipment and procedures, and prepare the hazard analysis required for the Test Equipment Data Package. The basic purpose of the Hazard Analysis Report section of the Test Equipment Data Package is to document the safety analysis performed to assure all causes of potential hazard have been addressed and adequate prevention controls have been implemented. The report should be of sufficient depth and detail so that technical personnel can determine if adequate hazard elimination or control has been accomplished or if additional hazard resolution analysis is required. The preparation of the Hazard Analysis Report should begin during the conceptual phase of the experiment as hazards are identified and should continue throughout the experiment's life cycle. The Hazard Analysis Report must be updated whenever changes to experiment design or operations affect a hazard condition.

The Hazard Analysis Report must contain a brief summary of the results of an intensive review of the experiment hardware and planned test operations to identify potential hazard sources inherent in either the experiment equipment or test operations. All hazards, especially those that could cause injury to flight test personnel or adversely affect the flight worthiness of the KC-135 aircraft, should be carefully assessed during this process, even if the possibility of occurrence might seem remote. The evaluator should note that a potential hazard should not be ignored and left unidentified just because stringent precautions have been taken to prevent the hazard from occurring. Such precautions are called "Hazard Controls" and both the hazard and the controls should be identified in the report.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 92 of 165

The Hazard Analysis Report consists of the Hazard Source Checklist and a detailed hazard description (sample forms are provided below). The experimenter shall complete the Hazard Source Checklist, enumerating all potential hazards, and its accompanying Detailed Hazard Description. Instructions for the Detailed Hazard Description are provided below:

Hazard Title—The title should be concise and descriptive.

Description of Hazard—This section should describe the potential hazard in terms of the risk to flight test personnel and to the flight worthiness of the KC-135 aircraft structure and flight systems. The experimenter should take care to identify the actual hazard as opposed to the hazard cause. For example, the over-pressurization of a tank is a hazard cause, whereas the possible explosion of the tank (with the potential for catastrophic consequences) is the actual hazard. In the same vein, a pressure relief valve attached to the tank would constitute a hazard control.

Hazard Causes—This section of the hazard report should identify and itemize all potential events or factors which could create the specific hazard in question. The number of factors that could induce a specific hazard could conceivably vary from one to perhaps 10 or more. It is very important that all possible causes be identified and analyzed. For example, the cause of a tank explosion could conceivably be any of the following factors:

- 1) Tank under-designed for maximum operating pressure
- 2) The pressure relief valve failed to open at the correct pressure
- 3) Tank not equipped with a pressure relief valve
- 4) One or more defective tank welds
- 5) Tank pressure gauge reading incorrectly
- 6) Tank failure because of operating procedure and/or software error

Each of the hazard causes identified above must be countered by one or more specific Hazard Control(s). These controls are discussed in the following section.

Hazard Controls—Particular emphasis must be placed on thoroughly developing the contents of this section of the Hazard Analysis Report. Hazard Control statements must be specific (don't generalize), complete (identify all controls applicable to the specific hazard), and definitive (provide adequate details to fully describe each control). This section must specifically identify the precise Hazard Control(s) utilized (such as design features, safety devices, warning devices, materials selection, and/or special operation procedures) that will eliminate, reduce, counter, or otherwise control the hazard(s) resulting from each Hazard Cause identified. Examples of acceptable Hazard Control statements for two of the Hazard Causes listed above might be:

The pressure vessel has been designed to sustain maximum expected operating pressure with a safety factor of 4.0.

Redundant pressure relief valves, calibrated at xxx psi, will be used on the pressurized tank.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 93 of 165

If the experimenter determines a potential hazard for which no suitable Hazard Control is available, the deficiency must be documented and provided to the KC-135 Test Director. This hazard will then be analyzed by NASA for a decision regarding risk acceptance.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 94 of 165

HAZARD SOURCE CHECKLIST

Enumerate or mark N/A

- _____ Flammable/combustible material, fluid (liquid, vapor, or gas)
- _____ Toxic/noxious/corrosive/hot/cold material, fluid (liquid, vapor, or gas)
- _____ High pressure system (static or dynamic)
- _____ Evacuated container (implosion)
- _____ Frangible material
- _____ Stress corrosion susceptible material
- _____ Inadequate structural design (i.e., low safety factor)
- _____ High intensity light source (including laser)
- _____ Ionizing/electromagnetic radiation
- _____ Rotating device
- _____ Extendible/deployable/articulating experiment element (collision)
- _____ Stowage restraint failure
- _____ Stored energy device (i.e., mechanical spring under compression)
- _____ Vacuum vent failure (i.e., loss of pressure/atmosphere)
- _____ Heat transfer (habitable area over-temperature)
- _____ Over-temperature explosive rupture (including electrical battery)
- _____ High/Low touch temperature
- _____ Hardware cooling/heating loss (i.e., loss of thermal control)
- _____ Pyrotechnic/explosive device
- _____ Propulsion system (pressurized gas or liquid/solid propellant)
- _____ High acoustic noise level
- _____ Toxic off-gassing material
- _____ Mercury/mercury compound
- _____ Other JSC 11123, Section 3.8 hazardous material
- _____ Organic/microbiological (pathogenic) contamination source
- _____ Sharp corner/edge/protrusion/protuberance
- _____ Flammable/combustible material, fluid ignition source (i.e., short circuit; under-sized wiring/fuse/circuit breaker)
- _____ High voltage (electrical shock)
- _____ High static electrical discharge producer
- _____ Software error or compute fault
- _____ Carcinogenic material
- _____ Other: _____
- _____ Other: _____
- _____ Other: _____

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 95 of 165

DETAILED HAZARD DESCRIPTION

Use the following format for describing each identified hazard in detail.

Hazard Number: _____

Title: _____

Hazard Description:

Hazard Cause(s):

Hazard Control(s):

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 96 of 165

6.15 Tool Requirements

In this section, include information regarding the tools you plan to bring to the Reduced Gravity facility, tools you plan to use on the airplane, and descriptions of tools you will need to borrow from the Reduced Gravity Office. Also include information on how your tools will be contained, inventoried, and limited in number to an absolute minimum. It is important to note that each tool must be marked to indicate its owner, have a proper storage location, and be accurately inventoried. Tools needed for flight shall be identified during the TRR briefing for approval and a copy of the tool inventory provided to a Test Director prior to each flight. Tools must be kept to an absolute minimum. A Test Director must approve all changes to the tool list prior to flight.

6.16 Photo Requirements

Researchers shall inform the Reduced Gravity Office of all photographic (still and video) requests for the documentation of the experiment. Please address the following questions:

- 1) Will a still photographer be requested for photo documentation during flight operations?
- 2) Will a videographer be requested to video-document your experiment during flight operations?
- 3) Will your experiment require the S-band downlink? If so, the researcher is responsible for the cost of the S-band downlink. Arrangements for use of the S-band downlink must be made with the Reduced Gravity Office **six weeks** prior to the researcher's arrival at Ellington Field.
- 4) How many camera poles will be required to mount video equipment for sufficient documentation of your experiment? ("Hands free" camera poles can be mounted in the airplane to locate camcorders and cameras at strategic angles for the documentation of your experiment)

6.17 Aircraft Loading

Use the following guidelines to meet documentation requirements for the Aircraft Loading section of the Test Equipment Data Package.

- 1) State what type of ground equipment you will need to load your experiment into the airplane, i.e. forklift, lifting pallet, J-bars, High Lift Truck, etc. (most equipment is loaded with a forklift and a lifting pallet.).
- 2) Describe your hardware manipulation strategy on the ground and in the KC-135 test cabin (i.e. lifting handles, casters, etc.). If lifting is required, handles must be available for enough personnel to limit the load to 50lbs per person.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 97 of 165

- 3) List the weights of the assemblies that are to be loaded onto the aircraft. State the base plate area for each assembly in square feet. Calculate and document the amount of load that will be placed on the aircraft floor in pounds per square foot during loading operations. If casters or J-Bars are to be used, calculate and document the weight that will be loaded on each wheel. The Reduced Gravity Office will determine if shoring is necessary and will be responsible for implementing all shoring procedures.

6.18 Ground Support Requirements

In this section of the Test Equipment Data Package, describe what you will need, in terms of ground support, from the Reduced Gravity Office. Please address the following questions:

- 1) What type of power will you need on the ground for testing research equipment?
- 2) Will you need any pressurized gas (NASA can provide breathing air, nitrogen, helium, argon)? Indicate the number of K-bottles that will be required for ground and flight operations. Any other pressurized gases will be the responsibility of the researcher (MSDS sheets must be provided). K-bottles can be delivered to the:

Reduced Gravity Office
Building 993, Ellington Field
Houston, Texas 77034

- 3) Will you be mixing or storing any chemicals that are toxic and/or corrosive? If so, what type of venting will be required?
- 4) Will you request access to building 993 (the Reduced Gravity Office) during hours other than normal business hours?
- 5) Do you have any general tool requests or a need for special ground handling equipment?

6.19 Hazardous Materials

Please state whether or not you will be using any toxic, corrosive, explosive, and/or flammable materials. Describe what the material is, how it will be used, and quantities being used. If possible, avoid the use of hazardous materials. If such materials are required for a test, proper containment must be provided. Please describe how you plan to safely contain and handle any hazardous materials. Early contact with the Reduced Gravity Office and the JSC Safety Office for discussions on proper use and containment of proposed hazardous materials may prevent delays in getting approval for the use of such materials. If such materials are necessary, provisions for dumping and purging in flight may be required. A current MSDS must be supplied for each hazardous material. For hazard material release calculations, the cabin volume is ≈ 4346 cubic feet. The cabin air exchange rate is one cabin volume per three minutes.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 98 of 165

6.20 Material Safety Data Sheets

In this section of the Test Equipment Data Package, include the Material Safety Data Sheets (MSDS) that apply to any chemical, fluid, etc. that you are utilizing with your experiment. MSDS sheets must be provided for all chemicals taken onto Johnson Space Center property. Copies of MSDS sheets must be kept with the chemicals at their ground-based storage areas.

6.21 Experiment Procedures Documentation

The information presented in this section of the Test Equipment Data Package will describe all of the procedures involved with operating your experiment at Ellington Field. These procedures should be comprehensive, beginning with the hardware arrival at Ellington Field and concluding with its shipment from Ellington Field. These procedures should be broken down in the following order:

Equipment Shipment to Ellington Field

State how equipment will be shipped to Ellington Field (i.e. freight, include shipping company name), when it will be shipped (i.e. month, day, and time), and what storage requirements are needed at Ellington Field to safely store your hardware (i.e. space requirements, temperature, etc). The researchers are responsible for all equipment sent to and from Ellington Field. The Reduced Gravity Office will not be responsible for any shipping arrangements. Please see Section 3.3.7 for additional information on the shipping and receiving of equipment to/from Ellington Field.

Ground Operations

State the procedures proposed to set-up and operate your equipment on the ground at Ellington Field. All equipment will be required to operate at the Test Readiness Review prior to flight. List the ground facilities/equipment you will require at Ellington Field (i.e. power, tools, forklift, etc.) to operate your equipment.

Loading

State the procedures proposed to load your equipment onto the aircraft (i.e. lifting strategy, tie-down strategy, etc.).

Pre-Flight

State the procedures proposed for pre-flight operations. Are there any special requirements regarding cabin temperatures, power availability, in-flight storage space, etc.?

Take-off/Landing

State any special procedures proposed during take-off and/or landing operations. Will there be any special equipment stowage requirements during take-off and landing? Will there be any power requirements during take-off and landing?

In-Flight

Provide a checklist including all procedures proposed for parabolic maneuvers, including just prior to and after parabolas. Include emergency procedures in this section.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 99 of 165

Post-Flight

State any special procedures proposed for readying equipment for the next day's flight.

Off-Loading

State any special procedures proposed for off-loading the equipment from the KC-135.
State the shipping arrangements that have been made for the removal of equipment from NASA property.

6.22 Bibliography

Please list any resources (include title, originator, and date) that were referenced in writing the Test Equipment Data Package. Provide footnotes in the body of the Test Equipment Data Package to designate where references were used. For each resource referenced in the bibliography, indicate volumes, chapters, pages, URL addresses, etc.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 100 of 165

7 TEST OPERATIONS

7.1 Pre-Flight

The test equipment should be received at JSC Ellington Field in a timely manner to allow for buildup, inspection, and the TRR. The address to use for shipping is:

Reduced Gravity Office
Building 993
Ellington Field
Houston, Texas 77034

The buildup and checkout of test equipment is solely the responsibility of the researcher. All tools and checkout equipment must be provided by the researcher since the shop facilities at Ellington are limited.

The TRR will normally be conducted in Building 993 one working day prior to the first flight. Test equipment, personnel, procedures, and documentation will be examined as indicated in paragraph 2.6. A simulated ground run may be required during this review whereby the researcher will demonstrate normal and contingency in-flight procedures. If approved for flight by the TRR, the equipment will subsequently be loaded on the aircraft. All researcher and engineering hardware will go through a TRR every visit to the Reduced Gravity Office. For hardware that has flown recently, a list of modifications to previously flown equipment and changes to test procedures must be provided to the Reduced Gravity Office no later than **six weeks** prior to flight.

A preflight safety briefing prior to boarding will be given to all flight personnel who have not flown on the aircraft within the previous six months. The briefing will cover the emergency equipment on board the aircraft and the emergency egress procedures. Flight suits and will be issued the morning of the first flight prior to the safety briefing. The typical preflight schedule is as follows:

8:00 Flight Suits Issued
8:15 Safety Video
8:45 Preflight Briefing
9:00 Board aircraft
9:30 – 11:30 Takeoff and Flight

7.2 In-Flight

All personnel aboard the aircraft will be under the direction of the aircraft flight crew and Test Directors, both for normal and emergency conditions and test operations. The Senior Test Director is in charge of all test activities, and the Aircraft Commander is the final authority for all operations from boarding through deplaning. Strict adherence to the authority of these personnel will be rigidly enforced. Any deviation from the flight-test plan must be discussed with a Test Director before implementation.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 101 of 165

7.3 Post-Flight

A post flight debriefing will be held immediately after landing to review any problems that occurred during the flight and to discuss possible alterations to the test hardware or test procedures.

Upon completion of the flight week, the equipment will be offloaded and prepared for shipment by the user. It is the researcher/user's responsibility to ensure that all test articles and materials used in his/her test (including compressed gas cylinders, chemicals, packing, and crating) are removed promptly from Building 993 to make room for incoming users. It is also the responsibility of the user to make arrangements for shipment of the test equipment back to the home base of operation. Be sure to advise your shipper that pickups must be made no later than 3:30 P.M., Monday through Friday only.

On the last flight day of the week, the Reduced Gravity Office will hand out a customer feedback form. Customer feedback received concerning the facilities, staff, and the Reduced Gravity Program, in general, is greatly appreciated. Customer feedback comments enables is to better serve our research and engineering customers.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 102 of 165

APPENDIX A

Reduced Gravity Aircraft Investigation Approval Questionnaire

1. Principal Investigator:

2. Organization Name, Contact, Address, Phone, Fax, and E-mail Info:

3. What is the Experiment Title (as shown in the MSAD bibliography)?

4. How was the research selected for funding? If by proposal, give the proposal title and selection date.

5. Is the research ground-based or a space flight program?

6. What is the approved term of this research program?

7. What is the science objective of investigation?

8. What are the specific objectives of the intended KC-135 flights and relevance to the overall program?

9. List of hardware required:

10. Future KC-135 plans:

Approved for flight by:

Chief Scientist/Chief Engineer/Designated Representative

Date

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 103 of 165

Appendix B

JSC REDUCED GRAVITY PROGRAM TEST READINESS REVIEW CERTIFICATION

- I. The following items have been tested for safety, technical adequacy and auditability:
- A. Personnel training, medical qualifications and documentation
 - B. Test system
 - C. Safety analysis and documentation
 - D. Aircraft systems and maintenance
- II. The following items are required to be accomplished prior to test initiation:
- A. _____
 - B. _____
 - C. _____
 - D. _____
- III. Test initiation is: ☐ Approved
 ☐ Approved pending corrections indicated in paragraph II.
 ☐ Not approved **Date**

 Test Conductor or designated representative (not mandatory)

 Reduced Gravity Program Test Director

 AOD Quality Assurance Section Representative

 KC-135A Project Pilot or designee

 IRB representative (if IRB protocol is involved)

 FCOD Flight Safety Office representative or designee

 JSC Safety Office representative or designee

 Chief, Aircraft Operations Division (AOD), (Chairman)
 or a designated representative.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 104 of 165

APPENDIX C

MEDICAL REQUIREMENTS

1. Examining physician **MUST** be certified as an FAA Medical Examiner or a designated Flight Surgeon.
2. Category I Personnel: Air Force Class III Flight Physical (see page 105).
3. Category II Personnel: KC-135 examination or its equivalent FAA Third Class Aviation Physical with required additional tests (see page 108).
4. These physicals must be submitted, reviewed and approved by the Human Test Support Group at Johnson Space Center (JSC) prior to participation in physiological training and boarding the KC-135 Microgravity Aircraft.

Results of the physical exam shall be sent to the following address **at least four (4) weeks prior to the training or flight date:**

Johnson Space Center

ATTN: Physiological Training Officer

Mail Code SD-27

Houston, TX 77058

FAX (281) 792-5731

All medical questions posed by examiners should be directed to the Physiological Training Officer at (281) 792-5724. The Chief of Aircraft Operations reserves the right to refer any KC-135 manifested person to the JSC Medical Office for a medical determination of the person's fitness for flight. The Chief of Medical Sciences Division at JSC is the final authority **on whether or not a person is physically qualified to fly on the KC-135 Reduced Gravity Aircraft.**

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 105 of 165

PHYSICAL REQUIREMENTS FOR AIR FORCE CLASS III FLIGHT PHYSICAL CATEGORY I

Category I Personnel:

Pilots

Astronauts

Payload Specialist

Aircrew

Suited subjects

Photographers

KC-135 Test Directors (FCOD personnel)

Flight Engineers

Aircraft Crew chiefs

Medical Officers

Any test subject involved in a flight requiring Level I or Level II medical coverage as mandated by the IRB

Frequency:

Yearly examinations are required.

Requirements:

Physical Examination & Medical History

Use SF-88 and SF-93 or FAA Form 8500-8 or JSC Form 8500. See pages 115 through 122.

Physician screening including:

- Health history, hiatal hernia examination (patient must provide a copy of the report from their personal physician), immunization, temperature, history of hypertension or heart problems, etc.

Health screening including:

- Initial X-ray (PA), thereafter as indicated by history or requested by examining physician.
- Laboratory analysis (see page 107).

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 106 of 165

- EKG
- Blood pressure (sitting, recumbent and standing)
- Pulse (sitting, recumbent and standing) - Exercise by jumping 100 times on either foot, clearing the floor by at least one inch and take immediate pulse, rest three minutes and take pulse again.
- Audiogram
- Visual screening (tonometry, heterophoria, accommodation, color vision, depth perception)
- Height and Weight (see page 113)
- Vital Capacity

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 107 of 165

LABORATORY ANALYSIS

Chemistry:

Glucose	61-114 m/dl
Bun	08-23 mg/dl
SGOT	06-48 IU/L
Cholesterol	108-200 mg/dl
SGPT	06-48 IU/L
Triglycerides	36-165 mg/dl
HDL	30-85 mg/dl
Ratios	CHOL: HD
Uric Acid	2.4-7 mg
RPR/VDRL	Non-reactive

Hematology

HGB	M = 16 (\pm 2) F = 14 (\pm 2) GM
HCT	M = 47 (\pm 7) F = 42 (\pm 5) %
WBC	4,500 - 10,000 / cubic mm
RBC	4,200,000 - 6,000,000 / cubic mm
MCV	85 - 100 cubic m
NEUT	54 - 62
LYMPHS	25 - 33
MONO/EOS	03 - 07/01 - 03
BASO/BANDS	00 - 02
MORPH PLATELETS	-

Urinalysis

Specific Gravity	1.010 - 1.025
pH	-
Glucose/Ketone	-
Protein/Bilirubin	-
Blood	-
WBC/RBC	-
Mucus	-
Epithelial Cells	-
Bacteria	-
Casts	-

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 108 of 165

KC-135 CATEGORY PHYSICAL REQUIREMENTS FOR

Reference: *FAA Guide for Aviation Medical Examiners* (see page 111)

KC-135 Personnel:

Pressure Suit Engineer / Technicians

Test Safety Officer

KC-135 Test Conductors / Investigators / Research Assistants

Observers

Chamber Directors / Operators / Conductors

Students involved in NASA sponsored programs

News Media representatives

Test subjects not involved with Level I or Level II type experiments

Any other personnel not included in the mandatory USAF Class III physical category and not mentioned in this group

Frequency:

Examinations are required every three (3) years.

Requirements:

Physical Examination & Medical History

Use SF-88 and SF-93 or FAA Form 8500-8 or JSC Form 8500. See pages 115 through 122.

Additional Requirements:

WEIGHT Requirement: MAXIMUM allowable weight is shown in the Height and Weight Tables on page 114

EKG: Required initially at age 35 and older, annually after age 40

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 109 of 165

REPORTING RESULTS

The examining physician may use one of the following options to report the results of the physical examination:

- Standard Form 88 (Report of Medical Examination, pages 115 and 116) and Standard Form 93 (Report of Medical History, pages 117 and 118) **or**
- FAA Form 8500-8 (report of Medical History and Examination, pages 119 and 120) **or**
- JSC Form 8500 (Report of Medical Examination, pages 121 and 122).

Physicians using other forms must include the results of all the parameters listed on pages 115 through 122. **Each page must contain the patient's name.**

Results from the following tests must be recorded in the blocks specified:

	SF-88	FAA Form 8500	JSC Form 8500	
<u>Information</u>	<u>Block #</u>	<u>Block #</u>	<u>Block #</u>	
Category I				
Urinalysis	45	57	48	
Chemistry / Hematology		50 or 73	Notes or 59	Notes or 51
Visual Screening	59 – 69	50 – 54	41 - 45	
X-ray (include date completed)		46	59	50
# EKG (include date completed)		48	58	49
Vital Capacity *	50	59	50	
Audiogram	71	49	40	
KC-135 Category				
Urinalysis	45	57	48	
+ X-Ray (include date completed)		46	59	50
# EKG (include date completed)		48	58	49

= If required by age + = as directed by history or as requested by examining physician

The results of the lab analysis for Block Hematology and Chemistry can be recorded in block 73 of SF-88, in the "Notes" of the FAA Form 8500-8 or JSC Form 8500 **as negative**.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 110 of 165

NOTE: Examining Physician's Comments on History and Findings are required.

The examining Physician **shall comment** of all "YES" answers in the "Medical History" section and for all abnormal findings of the examination on the SF-93 Item 25, FAA Form 8500-8, Item 60 or the JSC Form 8500, Item 51

MEDICAL AND PHYSIOLOGICAL DOCUMENTATION

All medical records of personnel stationed at JSC will be kept by the JSC Occupational Medical Clinic (Bldg. 8), medical records from personnel external to JSC are kept at the Human Test Subject facility (Bldg. 37). All other medical records shall be forwarded to:

Johnson Space Center
ATTN: Physiological Training Officer
Mail Code SD-27
Houston, TX 77058
FAX (281) 792-5731

Personnel receiving physiological training from other organizations must submit proof of completion of the training to the above address **OR** Fax it to (281) 792-5731.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 111 of 165

GUIDE FOR AVIATION MEDICAL EXAMINERS

Medical Certification Pilot Type	Medical Standards - Effective September 16, 1996																		
	First-Class Airline Transport Pilot	Second-Class Commercial Pilot		Third-Class Private Pilot															
DISTANT VISION	20/20 or better in each eye separately, with or without correction			20/40 or better in each eye separately, with or without correction															
NEAR VISION	20/40 or better in each eye separately (Snellen equivalent), with or without correction, as measured at 16 inches																		
INTERMEDIATE VISION	20/40 or better in each eye separately (Snellen equivalent), with or without correction at age 50 and over, as measured at 32 inches.			No requirement															
COLOR VISION	Ability to perceive those colors necessary for safe performance of airman duties.																		
HEARING	Demonstrate hearing of an average conversational voice in a quiet room, using both ears at 6 feet, with the back turned to the examiner <u>or</u> pass one of the audiometric test below.																		
AUDIOLOGY	Audiometric speech discrimination test: Score at least 70% discrimination in one ear.																		
	Pure tone audiometric test: Unaided, with threshold no worse than: <table><tr><td></td><td>500 Hz</td><td>1,000 Hz</td><td>2,000 Hz</td><td>3,000 Hz</td></tr><tr><td>Better ear</td><td>35 db 30 db</td><td>30 db</td><td>40 db</td><td></td></tr><tr><td>Worse ear</td><td>35 db 50 db</td><td>50 db</td><td>60 db</td><td></td></tr></table>					500 Hz	1,000 Hz	2,000 Hz	3,000 Hz	Better ear	35 db 30 db	30 db	40 db		Worse ear	35 db 50 db	50 db	60 db	
	500 Hz	1,000 Hz	2,000 Hz	3,000 Hz															
Better ear	35 db 30 db	30 db	40 db																
Worse ear	35 db 50 db	50 db	60 db																
ENT	No ear disease or condition manifested by, or that may reasonably be expected to be manifested by, vertigo or a disturbance of speech or equilibrium.																		
PULSE	No disqualifying per se. Used to determine cardiac system status and responsiveness.																		
BLOOD PRESSURE	No specified values stated in the standards. Hypertension covered under general medical standard and in <i>the Guide for Aviation Medical Examiners</i> .																		
ELECTRO-CARDIOGRAM (ECG)	At age 35 and annually after age 40	Not routinely required.																	
MENTAL	No diagnosis of psychosis, or bipolar disorder, or severe personality disorders.																		
SUBSTANCE DEPENDENCE AND SUBSTANCE ABUSE	A diagnosis or medical history of "substance dependence "is disqualifying unless there is established clinical evidence, satisfactory to the Federal Air Surgeon, of recovery, including sustained total abstinence from the substance(s) for not less than the preceding 2 years. A history of "substance abuse" within the preceding 2 years is disqualifying. "Substance " includes alcohol and other drugs (i.e., PCP, sedatives and hypnotics, anxiolytics, marijuana, cocaine, opioids, amphetamines, hallucinogens, and other psychoactive drugs or chemicals).																		

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 112 of 165

<p>DISQUALIFYING CONDITIONS *</p> <p>* BOLD print depicts new disqualifying conditions as of September 16, 1996. Substance dependence and substance abuse replace dependence and alcoholism.</p>	<p>Examiner must disqualify if the applicant has a history of: (1) Diabetes mellitus requiring hypoglycemic medication; (2) Angina pectoris; (3) Coronary heart disease that has been treated or, if untreated, that has been symptomatic or clinically significant; (4) Myocardial infarction; (5) Cardiac valve replacement; (6) Permanent cardiac pacemaker; (7) Heart replacement; (8) Psychosis; (9) Bipolar disorder; (10) Personality disorder that is severe enough to have repeatedly manifested itself by overt acts; (11) Substance dependence; (12) Substance abuse; (13) Epilepsy; (14) Disturbance of consciousness without satisfactory explanation of cause; and (15) Transient loss of control of nervous system function(s) without satisfactory explanation of cause.</p>
--	--

JSC Form 2156 (Sep 97)(MS Word Sep 97)

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 113 of 165

Height and Weight Tables for **CATEGORY I ONLY**:

CATEGORY I

HEIGHT AND WEIGHT TABLE

Male				Female		
Min wt. in pounds		Max wt. in pounds	Height in inches	Min wt. in pounds		Max wt. in pounds
98		149	58	88		132
99		151	59	90		134
100		153	60	92		136
102		155	61	95		138
103		158	62	97		141
104		160	63	100		142
105		164	64	103		146
106		169	65	106		150
107		174	66	108		155
111		179	67	111		159
115		184	68	114		164
119		189	69	117		168
123		194	70	119		173
127		199	71	122		177
131		205	72	125		182
135		211	73	128		188
139		218	74	130		194
143		224	75	133		199
147		230	76	136		205
151		236	77	139		210
153		242	78	141		215
157		248	79	144		221
161		254	80	147		226

NOTE: This is the MAXIMUM allowable weight for Category I only. **It does not apply to KC-135 Category personnel.**

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 114 of 165

Height and Weight Tables for **KC-135 CATEGORY ONLY**:

KC-135 CATEGORY

HEIGHT AND WEIGHT TABLE

Male				Female		
Min wt. in pounds		Max wt. in pounds	Height in inches	Min wt. in pounds		Max wt. in pounds
98		171.4	58	88		151.8
99		173.7	59	90		154.1
100		176	60	92		156.4
102		178.3	61	95		158.7
103		181.7	62	97		162.2
104		184	63	100		163.3
105		188.6	64	103		167.9
106		194.4	65	106		172.5
107		200.1	66	108		178.3
111		205.9	67	111		182.9
115		211.6	68	114		188.6
119		217.4	69	117		193.2
123		223.1	70	119		199
127		228.9	71	122		203.6
131		235.8	72	125		209.3
135		242.7	73	128		216.2
139		250.7	74	130		223.1
143		257.6	75	133		228.9
147		264.5	76	136		235.8
151		271.4	77	139		241.5
153		278.3	78	141		247.3
157		285.2	79	144		254.2
161		292.1	80	147		259.9

NOTE: This is the MAXIMUM allowable weight for KC-135 Category only. **It does not apply to Category I personnel.**

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide		JSC Reduced Gravity Program User's Guide	
		Doc. No. JSC 22803	Rev. D
		Date: October 2000	Page 116 of 165

MEASUREMENTS AND OTHER FINDINGS												
51. HEIGHT		52. WEIGHT		53. COLOR HAIR		54. COLOR EYES		55. BUILD: <input type="checkbox"/> SLENDER <input type="checkbox"/> MEDIUM <input type="checkbox"/> HEAVY <input type="checkbox"/> OBESE			56. TEMPERATURE	
57. BLOOD PRESSURE (Arm at heart level)						58. PULSE (Arm at heart level)						
A. SITTING		SYS.		B. RECUMBENT		SYS.		C. STANDING (5 min.)		SYS.		
DIAS.				DIAS.				DIAS.				
59. DISTANT VISION				60. REFRACTION				61. NEAR VISION				
RIGHT 20/		CORR. TO 20/		BY		S.		CX		CORR. TO		BY
LEFT 20/		CORR. TO 20/		BY		S.		CX		CORR. TO		BY
62. HETEROPHORIA (Specify distance)												
ES*		EX*		R.H.		L.H.		PRISM DIV.		PRISM CONV. CT		PC PD
63. ACCOMMODATION				64. COLOR VISION (Test used and result)				65. DEPTH PERCEPTION (Test used and score)		UNCORRECTED		
RIGHT LEFT										CORRECTED		
66. FIELD OF VISION				67. NIGHT VISION (Test used and score)				68. RED LENS TEST		69. INTRAOCULAR TENSION		
70. HEARING				71. AUDIOMETER						72. PSYCHOLOGICAL AND PSYCHOMOTOR (Tests used and score)		
RIGHT WV		/15 SV		/15		250 256		500 512		1000 1024		2000 2048
						3000 2896		4000 4096		8000 8144		8000 8192
LEFT WV		/15 SV		/15		RIGHT						
						LEFT						
73. NOTES (Continued) AND SIGNIFICANT OR INTERVAL HISTORY												
(Use additional sheets if necessary)												
74. SUMMARY OF DEFECTS AND DIAGNOSES (List diagnoses with item numbers)												
75. RECOMMENDATIONS—FURTHER SPECIALIST EXAMINATIONS INDICATED (Specify)								76. A. PHYSICAL PROFILE				
								P U L H E S				
77. EXAMINEE (Check)								B. PHYSICAL CATEGORY				
A. <input type="checkbox"/> IS QUALIFIED FOR												
B. <input type="checkbox"/> IS NOT QUALIFIED FOR												
78. IF NOT QUALIFIED, LIST DISQUALIFYING DEFECTS BY ITEM NUMBER								A B C E				
79. TYPED OR PRINTED NAME OF PHYSICIAN								SIGNATURE				
80. TYPED OR PRINTED NAME OF PHYSICIAN								SIGNATURE				
81. TYPED OR PRINTED NAME OF DENTIST OR PHYSICIAN (indicate which)								SIGNATURE				
82. TYPED OR PRINTED NAME OF REVIEWING OFFICER OR APPROVING AUTHORITY								SIGNATURE		NUMBER OF ATTACHED SHEETS		

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 117 of 165

STANDARD FORM 93
REV. OCTOBER 1974
PRESCRIBED BY GSA/ICMR
FPMR (41 CFR) 201-45.505

APPROVED
OFFICE OF MANAGEMENT AND BUDGET No. 29-R0191

REPORT OF MEDICAL HISTORY											
(THIS INFORMATION IS FOR OFFICIAL AND MEDICALLY-CONFIDENTIAL USE ONLY AND WILL NOT BE RELEASED TO UNAUTHORIZED PERSONS)											
1. LAST NAME—FIRST NAME—MIDDLE NAME						2. SOCIAL SECURITY OR IDENTIFICATION NO.					
3. HOME ADDRESS (No. street or RFD, city or town, State, and ZIP CODE)						4. POSITION (title, grade, component)					
5. PURPOSE OF EXAMINATION				6. DATE OF EXAMINATION		7. EXAMINING FACILITY OR EXAMINER, AND ADDRESS (Include ZIP Code)					
8. STATEMENT OF EXAMINEE'S PRESENT HEALTH AND MEDICATIONS CURRENTLY USED (Follow by description of past history, if complaint exists)											
9. HAVE YOU EVER (Please check each item)											
YES	NO	(Check each item)									
		Lived with anyone who had tuberculosis									
		Coughed up blood									
		Bled excessively after injury or tooth extraction									
		Attempted suicide									
		Been a sleepwalker									
10. DO YOU (Please check each item)											
YES	NO	(Check each item)									
		Wear glasses or contact lenses									
		Have vision in both eyes									
		Wear a hearing aid									
		Stutter or stammer habitually									
		Wear a brace or back support									
11. HAVE YOU EVER HAD OR HAVE YOU NOW (Please check at left of each item)											
YES	NO	DON'T KNOW	(Check each item)	YES	NO	DON'T KNOW	(Check each item)	YES	NO	DON'T KNOW	(Check each item)
			Scarlet fever, erysipelas				Cramps in your legs				"Trick" or locked knee
			Rheumatic fever				Frequent indigestion				Foot trouble
			Swollen or painful joints				Stomach, liver, or intestinal trouble				Neuritis
			Frequent or severe headache				Gall bladder trouble or gallstones				Paralysis (include infantile)
			Dizziness or fainting spells				Jaundice or hepatitis				Epilepsy or fits
			Eye trouble				Adverse reaction to serum, drug, or medicine				Car, train, sea or air sickness
			Ear, nose, or throat trouble				Broken bones				Frequent trouble sleeping
			Hearing loss				Tumor, growth, cyst, cancer				Depression or excessive worry
			Chronic or frequent colds				Rupture/hernia				Loss of memory or amnesia
			Severe tooth or gum trouble				Piles or rectal disease				Nervous trouble of any sort
			Sinusitis				Frequent or painful urination				Periods of unconsciousness
			Hay Fever				Bed wetting since age 12				
			Head Injury				Kidney stone or blood in urine				
			Skin diseases				Sugar or albumin in urine				
			Thyroid trouble				VD—Syphilis, gonorrhea, etc.				
			Tuberculosis				Recent gain or loss of weight				
			Asthma				Arthritis, Rheumatism, or Bursitis				
			Shortness of breath				Bone, joint or other deformity				
			Pain or pressure in chest				Lameness				
			Chronic cough				Loss of finger or toe				
			Palpitation or pounding heart				Painful or "trick" shoulder or elbow				
			Heart trouble				Recurrent back pain				
			High or low blood pressure								
12. FEMALES ONLY: HAVE YOU EVER											
											Been treated for a female disorder
											Had a change in menstrual pattern
13. WHAT IS YOUR USUAL OCCUPATION?											
14. ARE YOU (Check one)											
<input type="checkbox"/> Right handed <input type="checkbox"/> Left handed											

93-103

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 118 of 165

YES	NO	CHECK EACH ITEM YES OR NO. EVERY ITEM CHECKED YES MUST BE FULLY EXPLAINED IN BLANK SPACE ON RIGHT	
		<p>15. Have you been refused employment or been unable to hold a job or stay in school because of:</p> <p>A. Sensitivity to chemicals, dust, sunlight, etc.</p> <p>B. Inability to perform certain motions.</p> <p>C. Inability to assume certain positions.</p> <p>D. Other medical reasons (If yes, give reasons.)</p>	
		16. Have you ever been treated for a mental condition? (If yes, specify when, where, and give details.)	
		17. Have you ever been denied life insurance? (If yes, state reason and give details.)	
		18. Have you had, or have you been advised to have, any operations? (If yes, describe and give age at which occurred.)	
		19. Have you ever been a patient in any type of hospitals? (If yes, specify when, where, why, and name of doctor and complete address of hospital.)	
		20. Have you ever had any illness or injury other than those already noted? (If yes, specify when, where, and give details.)	
		21. Have you consulted or been treated by clinics, physicians, healers, or other practitioners within the past 5 years for other than minor illnesses? (If yes, give complete address of doctor, hospital, clinic, and details.)	
		22. Have you ever been rejected for military service because of physical, mental, or other reasons? (If yes, give date and reason for rejection.)	
		23. Have you ever been discharged from military service because of physical, mental, or other reasons? (If yes, give date, reason, and type of discharge: whether honorable, other than honorable, for unfitness or unsuitability.)	
		24. Have you ever received, is there pending, or have you applied for pension or compensation for existing disability? (If yes, specify what kind, granted by whom, and what amount, when, why.)	
<p>I certify that I have reviewed the foregoing information supplied by me and that it is true and complete to the best of my knowledge.</p> <p>I authorize any of the doctors, hospitals, or clinics mentioned above to furnish the Government a complete transcript of my medical record for purposes of processing my application for this employment or service.</p>			
TYPED OR PRINTED NAME OF EXAMINEE		SIGNATURE	
<p>NOTE: HAND TO THE DOCTOR OR NURSE, OR IF MAILED MARK ENVELOPE "TO BE OPENED BY MEDICAL OFFICER ONLY."</p> <p>25. Physician's summary and elaboration of all pertinent data (Physician shall comment on all positive answers in items 9 through 24. Physician may develop by interview any additional medical history he deems important, and record any significant findings here.)</p>			
TYPED OR PRINTED NAME OF PHYSICIAN OR EXAMINER		DATE	SIGNATURE
			NUMBER OF ATTACHED SHEETS

REVERSE OF STANDARD FORM 93

©U.S. Government Printing Office: 1989-241-757/80263

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide		JSC Reduced Gravity Program User's Guide	
		Doc. No. JSC 22803	Rev. D
		Date: October 2000	Page 120 of 165

NOTE: FAA's Copy of the Report of Medical Examination Must be TYPED.

REPORT OF MEDICAL EXAMINATION													
21. Height (inches)		22. Weight (pounds)		23. Statement of Demonstrated Ability (SODA)								24. SODA Serial Number	
				<input type="checkbox"/> YES		<input type="checkbox"/> NO		Defect Noted:					
CHECK EACH ITEM IN APPROPRIATE COLUMN				Normal	Abnormal	CHECK EACH ITEM IN APPROPRIATE COLUMN				Normal	Abnormal		
25. Head, face, neck, and scalp						37. Vascular system (Pulse, amplitude and character; arms, legs, others)							
26. Nose						38. Abdomen and viscera (Including hernia)							
27. Sinuses						39. Anus (Not including digital examination)							
28. Mouth and throat						40. Skin							
29. Ears, general (Internal and external canals; Hearing under item 49)						41. G-U system (Not including pelvic examination)							
30. Ear Drums (Perforation)						42. Upper and lower extremities (Strength and range of motion)							
31. Eyes, general (Vision under items 50 to 54)						43. Spine, other musculoskeletal							
32. Ophthalmoscopic						44. Identifying body marks, scars, tattoos (Size & location)							
33. Pupils (Equality and reaction)						45. Lymphatics							
34. Ocular motility (Associated parallel movement, nystagmus)						46. Neurologic (Tendon reflexes, equilibrium, senses, cranial nerves, coordination, etc.)							
35. Lungs and chest (Not including breasts examination)						47. Psychiatric (Appearance, behavior, mood, communication, and memory)							
36. Heart (Precordial activity, rhythm, sounds, and murmurs)						48. General systemic							
NOTES: Describe every abnormality in detail. Enter applicable item number before each comment. Use additional sheets if necessary and attach to this form.													
49. Hearing		Right Ear		Left Ear		Right Ear				Left Ear			
Voice Test						Audiometer Threshold in Decibels							
						500 1000 2000 3000 4000				500 1000 2000 3000 4000			
50. Distant Vision				51. Near Vision				52. Color Vision					
Right 20/		Corrected to 20/		Right 20/		Corrected to 20/		<input type="checkbox"/> Normal <input type="checkbox"/> Abnormal					
Left 20/		Corrected to 20/		Left 20/		Corrected to 20/							
Both 20/		Corrected to 20/		Both 20/		Corrected to 20/							
53. Field of Vision				54. Heterophoria 20' (in prism diopters)				Esophoria		Exophoria		Right Hyperphoria	
<input type="checkbox"/> Normal <input type="checkbox"/> Abnormal												Left Hyperphoria	
55. Blood Pressure				56. Pulse (Resting)		57. Urinalysis (if abnormal, give results)				58. ECG (Date)			
(Sitting, mm of Mercury)		Systolic Diastolic				Albumin Sugar				MM DD YY			
						<input type="checkbox"/> Normal <input type="checkbox"/> Abnormal							
59. Other Tests Given													
60. Comments on History and Findings: AME shall comment on all "YES" answers in the Medical History section and for abnormal findings of the examination. (Attach all consultation reports, ECGs, X-rays, etc. to this report before mailing.)												FOR FAA USE	
												Pathology Codes:	
												Coded By:	
												Clerical Reject	
Significant Medical History <input type="checkbox"/> YES <input type="checkbox"/> NO				Abnormal Physical Findings <input type="checkbox"/> YES <input type="checkbox"/> NO									
61. Applicant's Name				62. Has Been Issued — <input type="checkbox"/> Medical Certificate <input type="checkbox"/> Medical & Student Pilot Certificate									
				<input type="checkbox"/> No Certificate Issued — Deferred for Further Evaluation									
				<input type="checkbox"/> Has Been Denied — Letter of Denial Issued (Copy Attached)									
63. Disqualifying Defects (List by item number)													
64. Medical Examiner's Declaration — I hereby certify that I have personally reviewed the medical history and personally examined the applicant named on this medical examination report. This report with any attachment embodies my findings completely and correctly.													
Date of Examination				Aviation Medical Examiner's Name				Aviation Medical Examiner's Signature					
MM DD YY				Street Address									
				City State Zip				AME Serial Number					
								AME Telephone ()					

FAA Form 8500-8 (7-92) Supersedes Previous Editions

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 122 of 165

Report of Medical Examination Must be TYPED.

14. Height (inches)				15. Weight (pounds)				
CHECK EACH ITEM IN APPR. COLUMN		Normal	Abnormal	CHECK EACH ITEM IN APPR. COLUMN		Normal	Abnormal	
16. Head, face, neck, and scalp				28. Vascular system (Pulse, amplitude and character, arms, legs, others)				
17. Nose				29. Abdomen and viscera (Including hernia)				
18. Sinuses				30. Anus (Not including digital examination)				
19. Mouth and throat				31. Skin				
20. Ears, general (internal and external canals: Hearing under item 49)				32. G-U system (Not including pelvic examination)				
21. Ear Drums (Perforation)				33. Upper and lower extremities (Strength and range of motion)				
22. Eyes, general (Vision under items 50 to 54)				34. Spine, other musculoskeletal				
23. Ophthalmoscopic				35. Identifying body marks, scars, tattoos (Size & location)				
24. Pupils (Equality and reaction)				36. Lymphatics				
25. Ocular motility (Associated parallel movement, nystagmus)				37. Neurologic (Tendon reflexes, equilibrium, senses, cranial nerves, coordination, etc.)				
26. Lungs and chest (Not including breasts examination)				38. Psychiatric (Appearance, behavior, mood, communication, and memory)				
27. Heart (Precordial activity, rhythm, sounds, and murmurs)				39. General systemic				
<p>NOTES: Describe every abnormality in detail. Enter applicable item number before each comment. Use additional sheets if necessary and attach to this form.</p>								
40. Hearing		Right Ear	Left Ear	Audiometer Threshold in Decibels				
				500	1000	2000	3000	4000
Voice Test								
41. Distant Vision		Corrected to 20/		42. Near Vision		Corrected to 20/		43. Color Vision
Right 20/		Corrected to 20/		Right 20/		Corrected to 20/		<input type="checkbox"/> Normal <input type="checkbox"/> Abnormal
Left 20/		Corrected to 20/		Left 20/		Corrected to 20/		
Both 20/		Corrected to 20/		Both 20/		Corrected to 20/		
44. Field of Vision		45. Heterophoria 20' (in prism diopters)		Esophoria		Exophoria		Right Hyperphoria
<input type="checkbox"/> Normal <input type="checkbox"/> Abnormal								Left Hyperphoria
46. Blood Pressure (Sitting)		Systolic	Diastolic	47. Pulse (Resting)		48. Urinalysis (if abnormal, give results)		49. ECG (Date)
mm of Mercury		/				Albumin Sugar		MM DD YY
50. Other Tests Given				<input type="checkbox"/> Normal <input type="checkbox"/> Abnormal				
<p>51. Comments on History and Findings: AME's summary and elaboration of all pertinent data (AME shall comment on all positive answers in item 12. AME may develop by interview any additional medical history he deems important, and record any significant findings here.) AME shall comment on all "YES" answers in the Medical History section and for abnormal findings of the examination. Use additional sheets if necessary and attach to this form.</p>								
<p>Significant Medical History <input type="checkbox"/> Yes <input type="checkbox"/> No Abnormal Physical Findings <input type="checkbox"/> Yes <input type="checkbox"/> No</p>								
52. Applicant's Name		53. Disqualifying Defects (List by item number)						
<p>54. Medical Examiner's Declaration - I hereby certify that I have personally reviewed the medical history and personally examined the applicant named on this medical examination report. This report with any attachment embodies my findings completely and correctly.</p>								
Date of Examination		Aviation Medical Examiner's Name				Aviation Medical Examiner's Signature		
MM	DD	YY	Street Address					
				City		State		Zip
						AME Serial Number		
						AME Telephone ()		

JSC Form 8500 (Sep 97) (MS Word Sep 97)

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 123 of 165

APPENDIX D

PHYSIOLOGICAL TRAINING OUTLINE

Course Objective: To familiarize personnel who are exposed to a lowered barometric pressure with the physiological stresses encountered and how to successfully overcome these stresses.

I. Physics of the Atmosphere

A. Composition

B. Pressure Density

C. Layers and Characteristics

1. Troposphere

2. Stratosphere

D. Gas Laws

1. Boyle's Law

2. Henry's Laws

3. Dalton's Laws

4. Charles's Laws

5. Gaseous Diffusion

II. Respiration

A. Function of Respiration

B. Mechanics of Breathing

C. Gas transfer

1. External

2. Internal

3. Mechanics of Circulation and Blood Saturation

III Hypoxia

A. Definition

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 124 of 165

B. Types of Hypoxia

1. Hypoxic Hypoxia
2. Hypemic Hypoxia
3. Histotoxic Hypoxia
4. Stagnant Hypoxia

C. Symptoms Associated with Altitude

D. Times of Useful Consciousness

E. Treatment of Hypoxia

F. Factors Influencing Tolerance

IV. Hyperventilation

A. Definition

B. Causes

C. Symptoms

D. Treatment

V. Decompression Sickness

A. Definition

B. Trapped Gases

1. Ear
2. Sinus
3. Stomach and Intestines
4. Teeth
5. Lungs

C. Evolved Gas Disorders

1. Bends
2. Parasthesia
3. Chokes

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 125 of 165

4. False Chokes

5. Central Nervous System Disorders

D. Factors Affecting Tolerance

VI. Oxygen Equipment

A. Storage System

B. Breathing Systems

C. Delivery Systems

D. Safety

E. Pre-Flight Oxygen Checklist

VII. Spatial Disorientation

A. Definition

1. Illusion

2. Sensory Illusion

3. Orientation of Equilibrium

4. Spatial Disorientation

5. Vertigo

6. Pilot's Vertigo

B. Organs of Equilibrium

1. Visual

2. Proprioceptive

3. Vestibular

C. Vision

1. Anatomy

2. Autokinesis

3. Night Vision

D. Prevention of Spatial Disorientation

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 126 of 165

E. Overcoming Spatial Disorientation

VIII. Altitude Chamber Flight Profile I with Positive Pressure & Hypoxia Demonstration (See Figure 1 below. Letters on Figure 1 correspond to the outline below)

Astronauts
NASA Pilots
Medical Officers
Payload Specialist

A. Pre-Flight

1. Seating
2. Equipment Hookup
3. Pre-Flight Denitrogenation
4. Communications Check
5. Pre-Flight Chamber Systems Check

B. Ear and Sinus Check

C. Use of Specific Oxygen Equipment Used for Flight

1. Abdominal Gas Expansion
2. Evolved Gas Dysbarism
3. Review of Acute Hypoxia and Time of Useful Consciousness

D. Experience Pressure Breathing at 35,000 feet - Chamber Flight Profile I

E. Hypoxia Demonstration at 28,000 feet - Chamber Flight Profile I

1. Explanation of "Buddy System"
2. Special Instructions for Recovery from Hypoxia

F. Postflight Disposition of Oxygen Equipment used

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 127 of 165

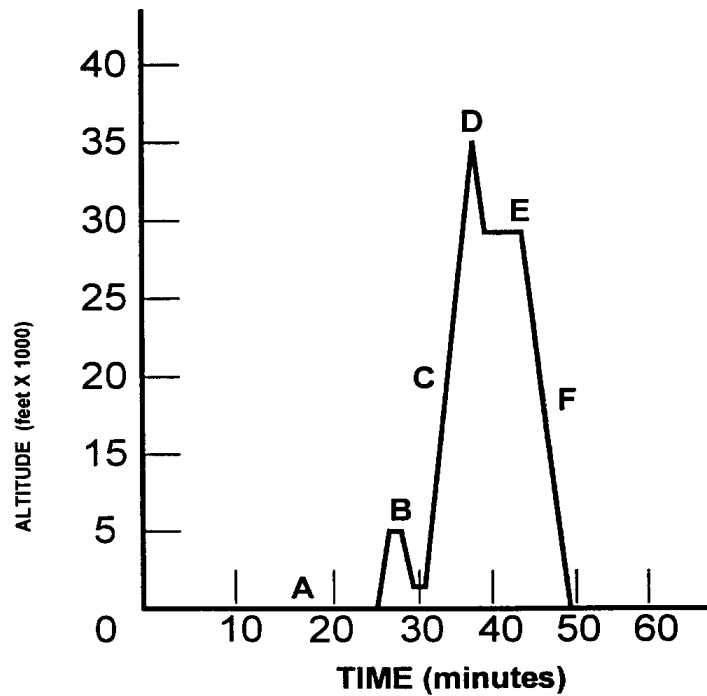


FIGURE 1 - Chamber Flight Profile I

IX. Altitude Chamber Flight Profile II with Positive Pressure & Hypoxia Demonstration
(See Figure 2 below. Letters on Figure 2 correspond to the outline below)

All Others not specified in Chamber Flight Profile I

A. Pre-Flight

1. Seating
2. Equipment Hookup
3. Pre-Flight Denitrogenation
4. Communications Check
5. Pre-Flight Chamber Systems Check

B. Ear and Sinus Check

C. Use of Specific Oxygen Equipment Used for Flight

1. Abdominal Gas Expansion
2. Evolved Gas Dysbarism
3. Review of Acute Hypoxia and Time Of Useful Consciousness

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 128 of 165

D. Hypoxia Demonstration at 25,000 feet - Chamber Flight Profile II

1. Explanation of Buddy System"
2. Special Instructions for Recovery from Hypoxia

E. Postflight Disposition of Oxygen Equipment used

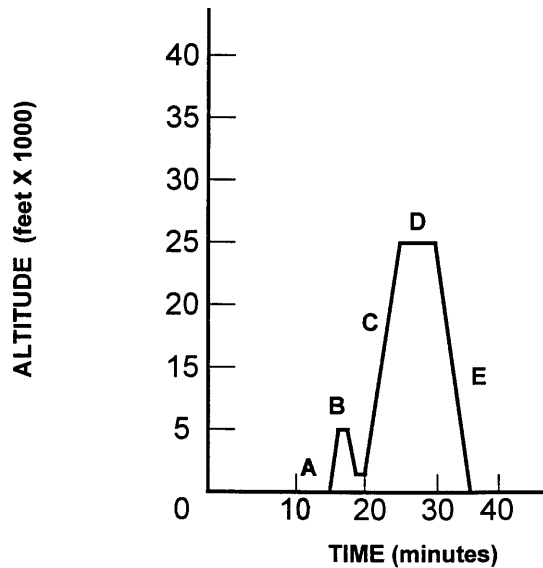


FIGURE 2 - Chamber Flight Profile II

X. Altitude Chamber Flight Profile Rapid Decompression (RD) Demonstration (See Figure 3 below. Letters on Figure 3 correspond to the outline below)

Rapid Decompression Profile applies to both Chamber Flight Profile. I and II

- A. Main Accumulator will ascend and level off at 25,000 ft.
- B. The Outside Lock will ascend to 8,000 ft.
- C. At 8,000 ft the RD will occur bringing the outside Lock to approximately 20,000.
- D. When all inside personnel give thumbs up, Outside Lock will descend to Ground level
- E. Postflight Disposition of Oxygen Equipment used

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 129 of 165

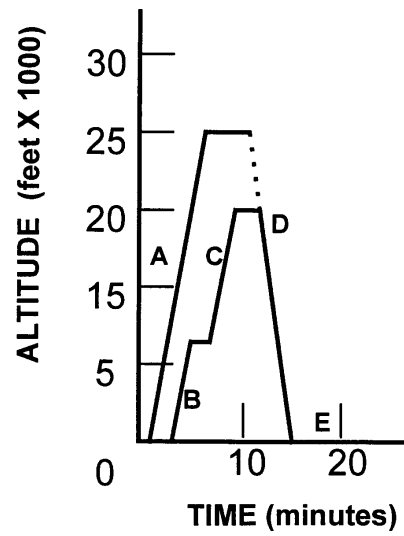


FIGURE 3 - Chamber Flight Profile Rapid Decompression

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 130 of 165

APPENDIX E

HUMAN RESEARCH MASTER PROTOCOL

Proposed JSC Reduced Gravity Program Research

Tentative Flight Dates _____

NOTE: All headings or statements in bold are to be included in the protocol and in the order listed.

1. TITLE

2. ORGANIZATION CONDUCTING THE RESEARCH

Normally the institution with which the Principal Investigator (PI) is affiliated.

3. INVESTIGATORS

- A. List all investigators starting with the PI, their addresses, and phone numbers. Attach curriculum vitae for each investigator at the end of the protocol.
- B. List technical personnel who will aid in and/or conduct the research. Attach qualifications at the end of the protocol. The Committee is interested in the qualifications of the technical staff that will be interacting with the test subjects because they will be operating equipment or performing procedures on them.

4. HYPOTHESIS(ES)

The hypotheses should be clearly and succinctly stated. The Committee must consider scientific merit as a factor in weighing risks vs. benefits. This summary should abstract the details to be included in Section 5.

5. PURPOSE OF RESEARCH

A. Historical Background

A brief background statement should trace the development of key factors or principles which led to the formulation of hypothesis. Reference to pertinent scientific literature is essential.

B. New Information Expected

6. JUSTIFICATION FOR USE OF HUMAN SUBJECTS

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 131 of 165

Explain why humans are a necessary part of the study.

7. STUDY PLAN AND SCHEDULE

Give an overview of what will be accomplished during preflight training/base-line data collection sessions, in-flight experimentation, and postflight data acquisitions. For example, familiarization with the concepts of the experiment, procedures to be learned, equipment to be used, data collection, etc.

A. Dates/Duration

Give as close an approximation as possible.

B. Place(s) of Training Test

C. Subjects

Provide names, dates of physicals and physiological training, and date consent form(s) signed for each subject.

8. EXPERIMENTAL PROTOCOLS AND EQUIPMENT

This section contains some of the most important information used by the Committee. It is from this section that the Committee may identify potential problems that might be overlooked by the investigators. Experience has shown that incompleteness of this section is one of the major reasons for IRB nonapproval.

A. Preflight Training and Baseline Data Collection

Describe preflight training and baseline data collection in terms of step-by-step procedures and equipment used. All equipment must be identified. In those instances where any hardware is used for training or ground-based testing, the PI is responsible for providing detailed descriptions and hazard analysis as an attachment to the protocol submittal. The PI is also responsible for maintaining configuration control of the hardware to prevent any modifications that would compromise the hazard analysis. Inspection records must be provided to assure the hardware configuration and to assure adherence to test requirements and procedures. Functional test and checkout of equipment utilizing non-flight crew personnel is required. All equipment, whether commercial, modified commercial, or custom designed, used for fit and functional testing, must be inspected by the JSC Safety Office. These results, together with equipment safety certification, must be submitted by the PI to the IRB prior to flight.

B. In-flight Activities

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 132 of 165

List step-by-step procedures and equipment used, approximate duration of the testing, how many flight personnel are necessary, and how many times the experiment will be performed.

C. Postflight Activities

If postflight testing of flight personnel is necessary, note how many times the test will be done, when, where, and what procedures and equipment will be used.

9. HAZARD ANALYSES AND SAFETY PRECAUTIONS

Detail the conceivable hazards that might be encountered during the study and the precautions that will be taken to avoid them. For research involving animal handling, list precautions employed for minimizing zoonoses.

A. Preflight Activities

1. Potential Hazards
2. Protection to Minimize Risks
3. Assessment of Residual Risks

B. In-flight Activities

1. Potential Hazards
2. Protection to Minimize Risks
3. Assessment of Residual Risks

C. Postflight Activities

1. Potential Hazards
2. Protection to Minimize Risks
3. Assessment of Residual Risks

10. POSSIBLE INCONVENIENCES OR DISCOMFORTS TO SUBJECTS

List additional factors that do not fall into the category of hazards, but that should be considered.

11. EXTENT OF PHYSICAL EXAMINATIONS

In many cases, reliance on the annual physical examination for flight personnel is all that need be stated. If a special physical examination or special test is required, describe it and state why it is needed.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 133 of 165

12. AVAILABILITY OF A PHYSICIAN AND MEDICAL FACILITIES

State if a flight surgeon and/or facilities will be required during preflight, flight, or postflight.

13. REQUIRED STATEMENTS FOR HUMAN RESEARCH SUBJECTS

- A. **"The subject will be free to withdraw from the research at any time.** Except . . .
(Describe any circumstances under which it would be hazardous or unwise to do so.)"
- B. "The identity of human subjects will not be released to the general public without his or her consent unless specifically required by law."
- C. "There will be no additional wage, salary, or other remuneration of any form paid, given, or in any manner delivered to the test subjects of this investigation where the subjects are NASA employees, NASA contractor employees or independent contractors, and the terms of the contracts with NASA provide for participation as subjects in approved experiments."
- D. "The human research subjects are NASA employees, NASA contractor employees or independent contractors, and the training/testing is part of their employment or contractual circumstances. Therefore, NASA is responsible for compensation for injury, death, or property damage to the extent required by the Federal Employees Compensation Act or the Federal Tort Claims Act."

14. REQUIRED ATTACHMENTS

- A. Include information concerning human research to be communicated to the subjects in the course of obtaining their informed consent. **Along with a signed consent form, attach a summary signed by the subject describing in layman's terms the procedures the subject will undergo.**

Include the following statement in the summary: "Since the KC-135 is considered to be a public aircraft within the meaning of the Federal Aviation Act of 1958, as amended, and as such does not hold a current airworthiness certificate issued by the Federal Aviation Administration (FAA), any individual manifested to board the KC-135 should determine before boarding whether his/her personal life or accident insurance provides coverage under such condition."
- B. If required, attach the appropriate JSC Consent Form to be employed (see Appendix 4). Specify the appendix designation in this section. If not required, so state.
- C. Attach a copy of the **Approval by the PI's Institutional Review Board** (Human Research or Ethics Committee). Specify the appendix designation.
- D. Attach a copy of the **Institutional Safety Authority's** most recent certification of all related equipment. Specify appendix designation(s).
- E. If external radiation sources or radionuclides are employed, their use must have the approval of the JSC Radiation Safety Committee. Attach a copy of the **Approval of the JSC Radiation Safety Committee**. Specify appendix designation.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 134 of 165

- F. Research use of drugs for indications not in the package insert is subject to Food & Drug Administration (FDA) restrictions. Prior to shipping the drugs in interstate commerce, either the sponsor (the manufacturer) or the clinical investigator must file form **FDA 1571, Notice of Claimed Investigational Exemption for a New Drug (IND)** with the FDA. The FDA regulations also require each clinical investigator who uses investigational drugs in humans to file with the sponsor of the investigational new drug (IND) either form **FDA 1572** or form **FDA 1573, Statement of Investigation**. Attach copies of the forms that have been filed and proof of submission date (e.g., certified mail receipt) or a statement of not having received a written reply from the FDA 60 days after the submission of forms. Attach a copy of the FDA reply, if it has been received.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 135 of 165

APPENDIX F

NASA/JSC HUMAN RESEARCH INFORMED CONSENT*

The following is from the *JSC Institutional Review Board Guidelines for Investigators Proposing Human Research for Space Flight and Related Investigations*, Space and Life Sciences Directorate (JSC-20483, Revision B).

1. I, the undersigned, do voluntarily give my informed consent for my participation as a test subject in the following research study, test, investigation, or other evaluation procedure:

NAME OF INVESTIGATION

FLIGHT TO WHICH ASSIGNED

PRINCIPAL INVESTIGATOR

RESPONSIBLE NASA PROJECT SCIENTIST

I understand or acknowledge that:

- (a) This procedure is part of an investigation approved by NASA.
- (b) I am performing these duties as part of my employment with

- (c) This research study has been reviewed and approved by the JSC Institutional Review Board (IRB) which has also determined that the investigation involves
_____ risk to the subject.
(minimal or reasonable)
- (d) Definitions:

"Minimal risk" means that the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.

"Reasonable risk" means that the probability and magnitude of harm or discomfort anticipated in the research are greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests, but that the risks of harm or discomfort are considered to be acceptable when weighed against the anticipated benefits and the importance of the knowledge to be gained from the research.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 136 of 165

- (e) The research procedures were explained to me prior to the execution of this form. I was afforded an opportunity to ask questions, and all questions asked were answered to my satisfaction. A layman's description was provided to me. **
- (f) I am medically qualified to participate in the investigation.
- (g) I know that I can refuse to participate in the tests at any stage of their performance, and physician, termination of the tests could have detrimental consequences for my health and/or the health of the other subjects. I further understand that my withdrawal or refusal to participate in this investigation will not result in any penalty or loss of benefits to which I am otherwise entitled.
- (h) In the event of physical injury resulting from this study and calling for immediate action or attention, NASA will provide or cause to be provided, the necessary treatment. I also understand NASA will pay for any claims of injury, loss of life or property damage to the extent required by the Federal Employees Compensation Act or the Federal Tort Claims Act. My agreement to participate shall not be construed as a release of NASA or any third party from any future liability which may arise from, or in connection with, the above procedures.
- (i) Except as provided for by Agency-approved routine uses under the Privacy Act, the confidentiality of any data obtained as a result of my participation as a research subject in this study shall be maintained so that no data may be linked with me as an individual. I understand, however, that if a life-threatening abnormality is detected, the investigator will notify me and the JSC Flight Medicine Clinic. Such information may be used to determine the need for care or medical follow-up, which, in certain circumstances, could affect my professional (flight) status.

Signature:

Signature:

Test Subject

Date

Witness

Date

2. I, the undersigned, the Principal Investigator of the investigation designated above, certify that:

- (a) I have thoroughly and accurately described the research investigation and procedures to the test subject and have provided him/her with a layman's description of the same.
- (b) The test setup involves _____ risk to the test subject. All equipment to be used
(minimal/reasonable)
has been inspected and certified for safe and proper operation.
- (c) The test subject is medically qualified to participate.
- (d) Except as provided for by Agency-approved routine uses under the Privacy Act, the confidentiality of any data obtained as a result of the test subject's participation in this study shall be maintained so the no data may be linked to him/her as an individual.
- (e) The test protocol has not been changed f torn that originally approved by the JSC IRB.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 137 of 165

Signature:

Signature:

Principal Investigator

Date

NASA Project Scientist

Date

Notes:

- * This form is valid for the period including preflight in-flight, and postflight data collection sessions for the mission. Before the first baseline data collection, the Principal Investigator will repeat the briefing concerning risks involved in the investigation. A signed, dated copy of this form with attachments must be forwarded to Chairperson, Johnson Space Center Institutional Review Board, Attn: Dr. Lawrence Dietlein, Mail Code SA, Lyndon B. Johnson Space Center, Houston, Texas 77058.
- ** A detailed description of the investigation will be attached to this consent form. The Principal Investigator is responsible for formulating this document, which should be in layman's terms such that the subject clearly understands what procedures will be required of him/her and the risks associated therewith.

The detailed description of the research must, at a minimum, include the following:

- (1) An explanation of the purposes of the research and the expected duration of the subjects participation, a description of the procedures to be followed, and identification of any procedures which are experimental;
- (2) A description of any reasonably foreseeable risks or discomforts to the subject, including, but not limited to, possible adverse reactions of all medications to be administered and any risks/hazards resulting from exposure to ionizing radiation;
- (3) A description of any benefits to the subject or to others which may reasonably be expected from the research;
- (4) A disclosure of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to the subject;
- (5) A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained;
- (6) Clarification of all forms of behavior, if any, interdicted by the research protocol (e.g., exercise, diet, medications, etc.); and
- (7) An explanation of whom to contact for answers to pertinent questions about the research and research subjects' rights, and whom to contact in the event of a research-related injury to the subject.

When appropriate, the following information shall also be provided in the detailed description:

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 138 of 165

- (8) A statement that the particular treatment or procedure may involve links to the subject (or to the embryo or fetus, if the subject is or may become pregnant) which are currently unforeseeable;
- (9) Anticipated circumstances under which the subject's participation may be terminated by the investigator without regard to the subject's consent;
- (10) Any additional costs to the subject that may result from participation in the research;
- (11) The consequences of a subjects decision to withdraw from the research and procedures for orderly termination of participation by the subject;
- (12) A statement that significant new findings developed during the course of the research which may relate to the subject's willingness to continue participation will be provided to the subject; and
- (13) The approximate number of subjects invoked in the study.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 139 of 165

Appendix G

Zero g Video Dub Request Form

The Zero-G video request may be typed as a simple interoffice communication and will require approval from the Reduced Gravity Office.

E-Mail requests are acceptable. E-mail the Reduced Gravity Office with this form: zerogl@jsc.nasa.gov. The Reduced Gravity Office will forward your request to the video customer service desk.

The normal turn-around time is 5 working days. The video request should have the following essential information.

- * Customer Name
- * Customer Address, City, State and Zip
- * Customer Phone Number
- * University, School or Organization
- * Fed Ex charge account number (otherwise videos will be sent via U.S. Postal Service)
- * Customer NASA Organizational Code (typically the mail code)
- * Title (s) of original videotape(s) to be duplicated
- * Flight Date
- * Number of duplicates requested for each title
- * Required format(s) of video tape copies (VHS, Beta SP, Hi-8 mm etc.)
- * Date duplications are needed by

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 140 of 165

Appendix H

Glenn Research Center Operations



Figure 34 : Glenn Research Center Buildings 101 & 4

1. KC-135 Operations at Glenn Research Center – Cleveland, Ohio

The KC-135 is regularly operated from the Glenn Research Center (GRC) for the primary purpose of supporting Microgravity Science and Applications Division sponsored experiments, which are developed and or managed by the Glenn Microgravity Science Division. Other investigators may participate in GRC based KC-135 flights on a space available basis. The procedures outlined in this appendix are ONLY for those researchers who will be conducting microgravity research on the KC-135 Reduced Gravity Aircraft when the aircraft is deployed to Glenn Research Center in Cleveland, Ohio and are specific to the Glenn Research Center operations.

Researchers should refer to the basic KC-135 User's Guide for all other program and experiment specific information.

1.1 Reduced –Gravity Aircraft Operations Office – Building 101

The GRC Reduced-Gravity Aircraft Operations facility provides visiting researchers with a work area for experiment assembly, checkout, and operation of KC-135 experiments in preparation for and during the KC-135 flight week. Office space, a data reduction and conference area, aircraft power source, vacuum pumps, gas bottle storage, engineering staff, technicians, standard

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 141 of 165

diagnostic equipment, minor machine tooling, general and small part supply, data processing, post-flight video replay and duplication capabilities are available in the facility or the adjoining hangar. Mechanical and electronics technicians are also on site in Building 101 to provide assistance to visiting researchers with the assembly, installation, and troubleshooting of their experiment hardware. Building 101 is located adjacent to the Flight Research Building (Building 4).

NASA Glenn Research Center
Reduced-Gravity Aircraft Operations Office

Eric Neumann, Mechanical Engineer, 216-433-2608, eric.neumann@grc.nasa.gov
Experiment Scheduling
Safety
Experiment Mechanical Engineering
Shipping
Budget

Jim Withrow, Electrical Engineer, 216-433-8315, james.withrow@grc.nasa.gov
Experiment Scheduling
Experiment Electrical Engineering
Physiological Training Scheduling
KC-135 Flight Manifests
Data Acquisition / Acceleration Environment

Mike Dobbs, Mechanical Engineer, 216-433-3611, michael.dobbs@grc.nasa.gov
Experiment Mechanical Engineering

Chris Hegedus, Electrical Engineer, 216-433-8496, chris.hegedus@grc.nasa.gov
Experiment Electrical Engineering

1.2 Glenn Research Center Provided Support

Because the Glenn Research Center is a research facility, numerous specialized support facilities and personnel are available for visiting researchers' use. Researchers should contact the Reduced-Gravity Aircraft Operations Office to discuss specific needs.

1.3 Normal Duty Hours Building 101

The Reduced-Gravity Aircraft Operations Office (Building 101) is open for normal operations Monday through Friday from 6:30 a.m. to 4:00 p.m. Access to the Flight Research Building (Building 4) hangar floor and the KC-135 is limited to these hours unless prior arrangements are made with the Reduced-Gravity Aircraft Operations Office.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 142 of 165



Figure 35 : Building 101 (Exterior and High-Bay)

1.4 Telephones at GRC

Telephones with access to local and long distance lines are available in Building 101. All long-distance charges must be for official use or be handled collect or third party by the researcher. Incoming calls for researchers should use the following numbers: 216-433-2611, or 216-433-2612. The FAX number is 216-433-2614.

1.5 Security and Access to Glenn Research Center

Access to Glenn is restricted to properly approved (badged) persons. After- hours or weekend entrance must be coordinated in advance by with the Reduced-Gravity Aircraft Operation Office. Persons needing access after normal duty hours will be put on the "after hours" listing at the main gate with the responsible NASA person indicated and a telephone number where he or she can be reached. While at Glenn all personnel must display their visitor badges and all international visitors must be escorted while on site. Upon completion of your visit to the Glenn

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 143 of 165

Research Center, all visitor badges **must** be returned to the Main Gate upon leaving.

1.5.1 U.S. Citizens

Researchers visiting to Glenn who are U.S residents must contact their Glenn experiment technical contact **one week** prior to their arrivals, so that visitor badges can be processed. Visitor badges will be at the Glenn main gate on the day the researchers arrive. The technical contact will need to know the full name, affiliation (employer or school), arrival and departure date off **all** persons visiting.

U.S. citizens working for a company or corporation headquartered outside the United States will be treated as international visitors and must also complete a Non-US Citizen Access Request, NASA C-216 form (same procedure as citizens of another country). People in this category are listed as "foreign representatives."

1.5.2 Foreign Nationals

International visitors must contact their Glenn experiment technical contact no later than **four weeks** prior to their arrival, so that the paperwork can be accomplished in a timely manner. Failing to do so will result in delays in acquiring Glenn visitor badges.

International visitors must provide their respective embassies in Washington, DC, with the purposes, points of contact, and dates of their visits to Glenn. The embassies must receive the request for access at least **one month** prior to the actual visit; the embassies in turn will receive a confirmation from NASA Headquarters' International Planning and Programs Office when the visit has been approved. NASA Headquarters will also send the proper authorization to Glenn. International visitors must bring their passports and complete a NASA C-906 at the Glenn main gate on the first day of a visit. International visitors must carry their passports with them at all times.

Persons who have a Permanent Resident Alien Card ("green card") may receive their badges directly at the Glenn main gate upon presentation of the original green card. The stamp in the passport is not sufficient; the original green card is required. The process for a permanent "green card" holder visiting Glenn would be the same as a U.S. Citizen.

When international visitors arrive at the Glenn Main Gate, they will be required to fill out a five-year history of residence and employment, NASA C-906. Passports are required.

The sponsor of the international visitor will be responsible for escorting or designating an escort for the entire time the international visitor is at Glenn. International visitors must be escorted at **all times**. They are not authorized to roam any building, or be left in any area alone. An international visitor will have their access privileges immediately terminated if their sponsor or escort does not properly supervise them. The sponsor or escort will be responsible for making sure that all personnel in the area are aware that an international visitor is scheduled to visit and making sure people in the area understand what information the visitor is authorized to receive. The sponsor is responsible for ensuring the international visitor's badge is returned to the main

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 144 of 165

gate upon completion of the visit.

The following items are prohibited to be brought onto the Glenn Research Center by international visitors without prior coordination and approval from the Glenn Security Management Office:

- Computer Devices (Personal Computer, Palm Pilots, Personal Organizers, Programmable Calculators, etc.)
- Cellular Phones, Two-way pagers, other communication devices
- Magnetic Media Information Storage Devices (Disks, Tapes, etc.)
- Photographic Equipment (video, still frame cameras, etc.)
- All types of Information Devices, or other magnetic media (watches with storage or Infra Red capabilities, tape recorders, etc.)

1.6 Shipping, Receiving and Storage at GRC

All research hardware that require shipping must be sent to:

- NASA Glenn Research Center
- Reduced-Gravity Aircraft Operation Office
- MS 101-1, Building 101
- 21000 Brookpark Road
- Cleveland, Ohio 44135

Each researcher (operator) is responsible for ensuring that his or her research hardware is packaged and the shipping documents (NASA-C-10009, Shipping Request/ Authorization) are completed **one day** prior to leaving Glenn. The Reduced-Gravity Aircraft Operation Office will contact Glenn transportation for pickup of the research hardware. All international researchers are required to arrange for the delivery and pickup of their hardware. It is recommended that a shipping broker be employed to take care of all customs paperwork both at the shipping and receiving locations.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 145 of 165

1.7 Local Area Maps and Hotel and Restaurant Information for GRC

A map and list of local hotels and restaurants and their telephone numbers are included as Figure 34. A map of the area surrounding Glenn is shown in figure 35 to give the first-time visitor to Cleveland and Glenn a feel for the area. A map of Glenn is given in Figure 36.

Hotels:

Hotel/Motel	Address	Phone
Cross Country Inn	7233 Engle Rd. Middleburg Hts., Ohio	216-243-2277
Fairfield Inn Marriott	16644 Snow Rd. Brook Park, Ohio	216-676-5200
Hampton Inn	25105 Country Club Blvd. North Olmsted, Ohio	216-734-4477
Harley Hotel Cleveland West	17000 Bagley Rd. Middleburg Hts., Ohio	216-243-5200
Holiday Inn-Hopkins Int'l	7230 Engle Rd. Middleburg Hts., Ohio	216-243-4040
Marriott Inn	4277 W. 150 St. Cleveland, Ohio	216-252-5333
Motel 6	7219 Engle Rd. Middleburg Hts., Ohio	216-234-0990
Radisson Inn	25070 Country Club Blvd. North Olmsted, Ohio	216-734-5060
Residence Inn (Airport)	17525 Rosbough Dr. Middleburg Hts, Ohio	440-234-6688
Residence Inn (I480/I77)	5101 West Creek Rd Independence, Ohio	216-520-1450
Red Roof Inn	17555 Bagley Rd. Middleburg Hts., Ohio	440-243-2441
Sheraton Hopkins Airport	5300 Riverside Dr. Cleveland, Ohio	216-267-1500

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 146 of 165

Signature Inn 17550 Rosbough Dr. 440-234-3131
Middleburg Hts., Ohio

Restaurants:

Restaurant	Address	Phone
Bob Evans	17011 Bagley Rd. Middleburg Hts., Ohio	243-6060
Chi Chi's	Great Northern Plaza North Olmsted, Ohio	734-0300
Chili's	Country Club Blvd. at I-480 North Olmsted, Ohio	777-0117
Ground Round	24250 Lorain Rd. North Olmsted, Ohio	779-7173
Macaroni Grill	Country Club Blvd. at I-480 North Olmsted, Ohio	734-9980
Manhattan Deli	24180 Lorain Rd. North Olmsted, Ohio	734-8500
Mountain Jacks	Brookpark at Great Northern Blvd. North Olmsted, Ohio	777-7277
100th Bomb Squadron	20000 Brookpark Rd. Cleveland, Ohio	267-1010
Olive Garden	25984 Lorain Rd. North Olmsted, Ohio	234-0888
Olive Garden	17500 Bagley Rd. Middleburg Hts., Ohio	234-6845
Perkins	7175 Engle Rd. Middleburg Hts., Ohio	234-7393
Pufferbelly LTD	30 Depot Street (by Freeway) Berea, Ohio	234-1144
T.G.I. Friday's	5200 Great Northern Mall North Olmsted, Ohio	777-5040
Tony Romas	Great Northern Plaza North Olmsted, Ohio	777-2300

Verify that this is the correct version before use.

Wah Fu

15210 Bagley Rd.
Middleburg Hts., Ohio

886-3456

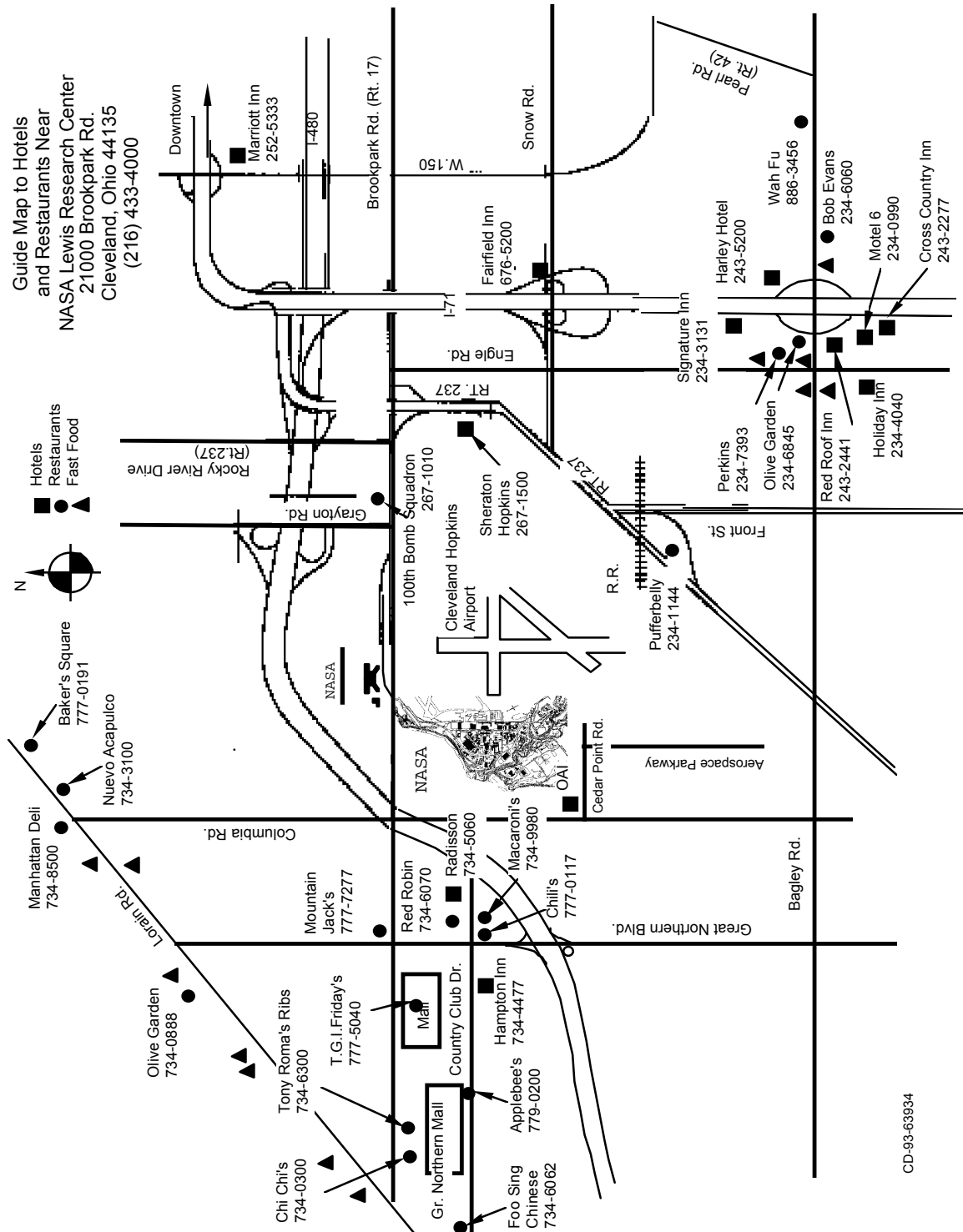


Figure 36: Local Hotels and Restaurants at Glenn Research Center

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 148 of 165

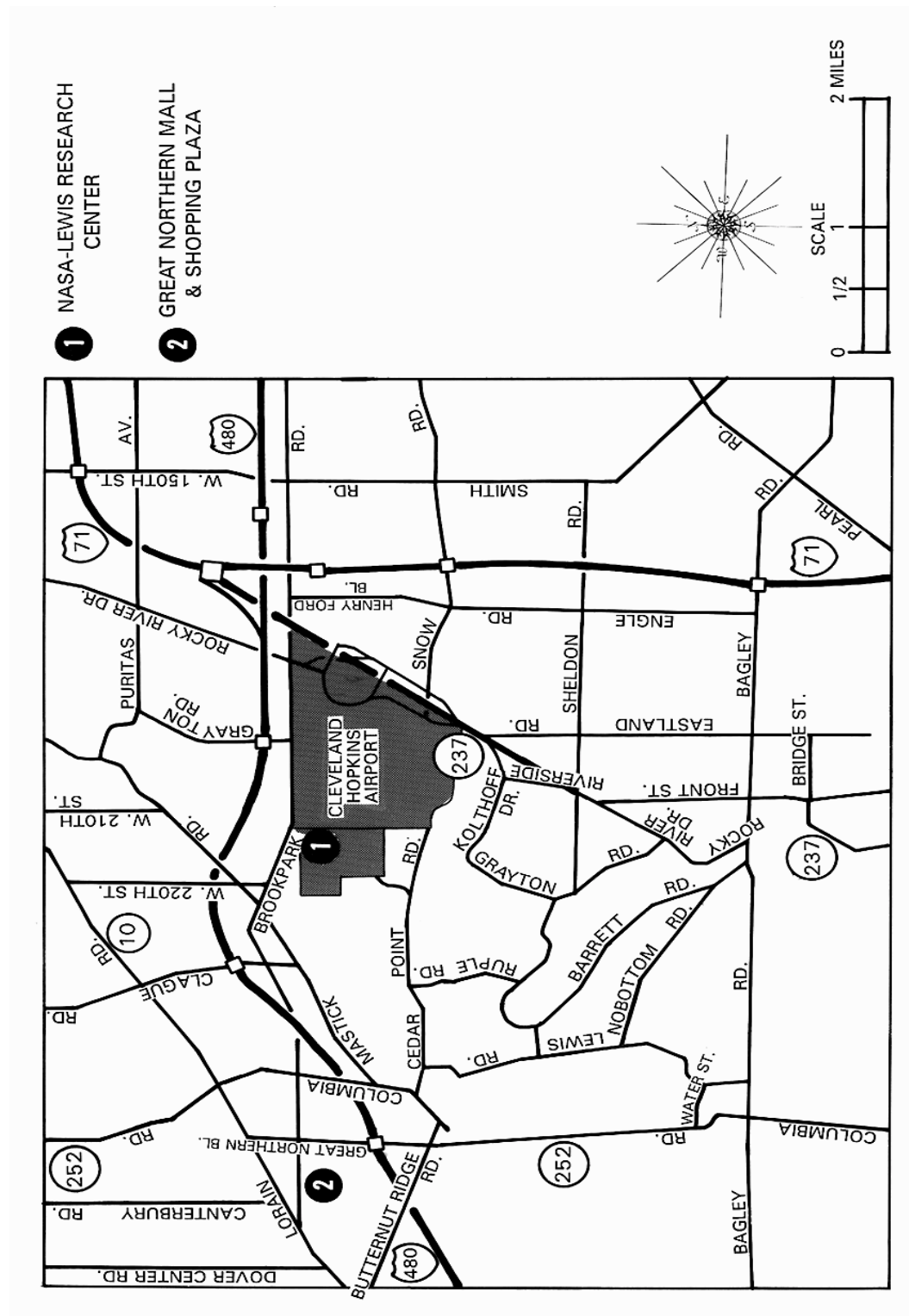


Figure 37: Local Area Map of Glenn Research Center
Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 149 of 165

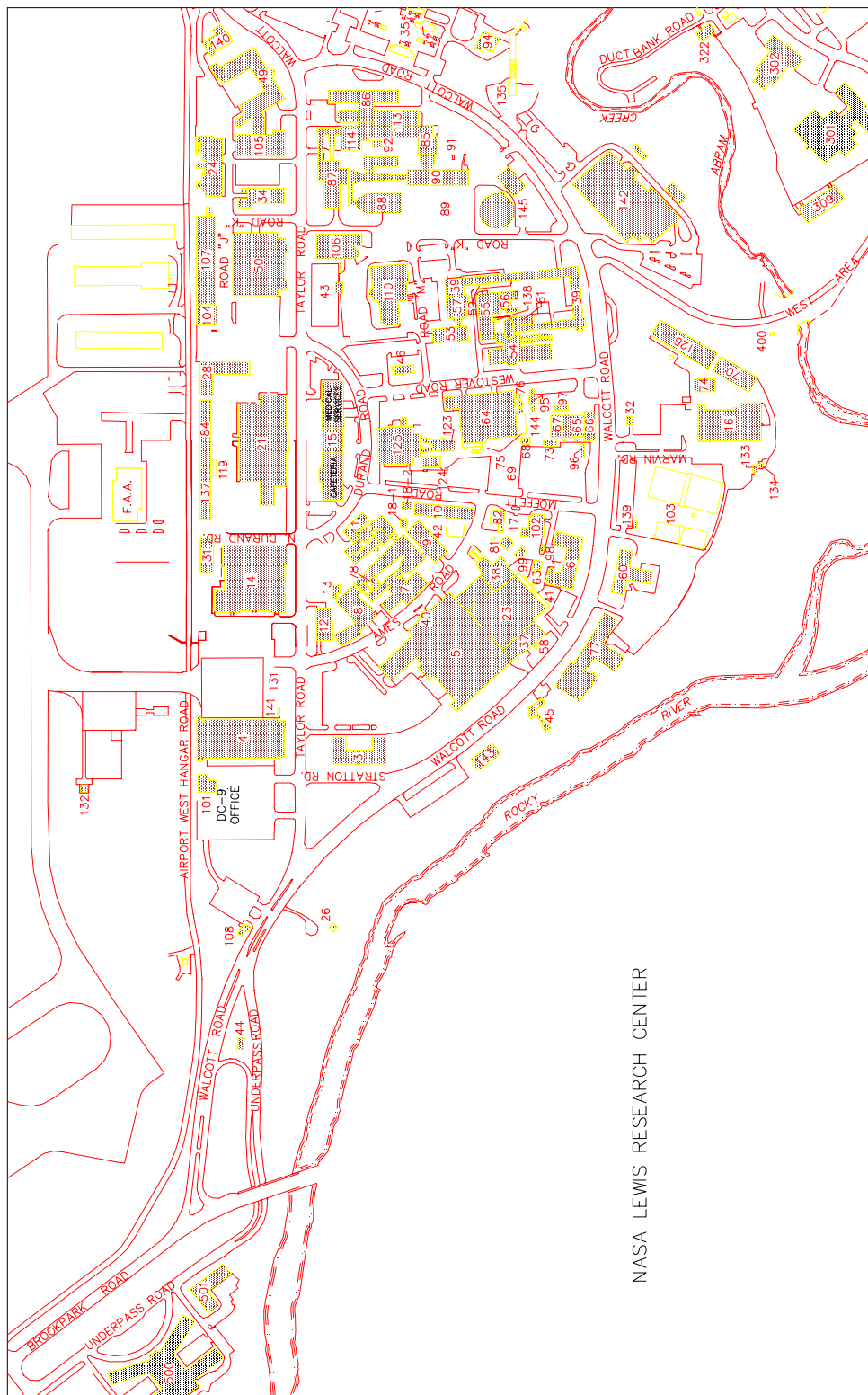


Figure 38: Glenn Research Center Map

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 150 of 165

2.0 User Procedures

GRC managed researchers should follow the procedures outlined in Section 4 of the User's Guide. All required submission should be forwarded to the GRC Reduced-Gravity Aircraft Operations Office, who will in turn coordinate with the JSC Reduced Gravity Office. Research involving human test subjects, animals, or biological tests will not be conducted at Glenn Research Center.

Researchers should follow the guidelines below:

- The GRC technical monitor for the experiment should review the proposed design of experiment hardware and experiment operation prior to fabrication. The NASA GRC technical monitor should obtain support if required from the GRC Reduced Gravity Aircraft Operations Office or other Glenn Microgravity Science Division personnel.
- The researcher will contact their GRC technical monitor to schedule microgravity flights. The GRC technical monitor, not the researcher, will schedule the experiment with the GRC Reduced Gravity Aircraft Operations Office, which in turn will handle all the scheduling details with JSC.
- The GRC technical monitor should receive the experiment safety documentation, review it, and then submit the safety documentation to the GRC Reduced Gravity Aircraft Operations Office at least six weeks prior to flight. The GRC Reduced Gravity Operations Office is available to consult on safety issues and can provide a preliminary review of draft safety documents.

3.0 Test Personnel Data GRC

All personnel shall provide the results of a current KC-135 Examination (See paragraph 4.3.1 and Appendix C) as a minimum. NASA and military personnel may obtain the KC-135 Examination at the nearest NASA or military medical facility. NASA employees assigned to Glenn may obtain the KC-135 Examination through the Glenn Occupational Medicine Services Clinic in Building 15.

Persons who choose to obtain the KC-135 Examination from an aeromedical examiner other than a NASA or military physician will be responsible for any cost incurred). Results of the physical must be sent to Johnson Space Center (See paragraph 4.3.3).

Additionally, those researchers who will be flying on the KC-135 at Glenn Research Center must also send the results of physical to Glenn Occupational Medicine Services (FAX 216/433-6529). Medical records are required to be on file with the NASA center where flight activity is occurring. Motion sickness medication will not be dispensed to the individual if his or her medical information is not on file with the Glenn Occupational Medicine Services.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 151 of 165

Results of physicals must be sent to the following address at least **four weeks** prior to the flight date:

NASA Glenn Research Center
Occupational Medicine Services Clinic
MS 15-5
21000 Brookpark Road
Cleveland, OH 44135

3.1 Physiological Training

Researchers must follow the guidelines in paragraph 4.3.2 and 4.3.3

4.0 Safety Policy

Researcher shall follow the guidelines established in section 2 , 5 and 6 of User's guide. For Glenn Research Center operations investigators must have a safety permit issued by the Glenn Research Center Aviation Safety Committee. No experiment can fly on the KC-135 at Glenn Research Center without an approved safety permit. It does not matter if an experiment has already flown on the KC-135 at Ellington Field or not. All experiments that fly on the KC-135 out of Glenn Research Center shall abide by the Glenn Research Center Safety Policies.

Researchers must submit 10 copies of the Test Equipment Data Package to the Reduced Gravity Aircraft Operations Office at Glenn Research Center **six weeks** prior to flight. The members of the GRC Reduced Gravity Aircraft Operations Office will review the TEDP's and apply for the required safety permits.

5.0 Operational Requirements

The operational requirements are the same at Glenn Research Center as they are at Ellington Field.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 152 of 165

APPENDIX I

PRE-SHIPMENT EQUIPMENT READINESS CHECKLIST

This checklist was adapted from the Deutsche Luft-und Raumfahrt (DLR) *KC-135 Test Equipment Inspection Procedures*. As overseas veterans of numerous zero-g campaigns, DLR is uniquely qualified to recommend a final, pre-shipment equipment checklist. However, this checklist, although useful during packing preparations, does not replace the safety requirements outlined in this document.

A. General

Has the flight equipment been identified? Has the ground equipment been identified?
Have the flight procedures been prepared?

Have the contingency flight procedures been prepared (power failure, computer failure, need for spare batteries, etc.)?

Have the operational limits been defined?

Has the detailed structural analysis been performed (takeoff and landing configuration, free-floating test article configuration)?

Has the electrical load analysis been performed?

Is the general workmanship satisfactory (screws and bolts secure, wiring secure, cable routing convenient and safe, components secure on base-plates)?

B. Human Factors

Have all of the corners, edges, and protrusions been padded?

Are all surface temperatures below 113 degrees Fahrenheit?

Are all rotating components contained?

Are all electrical connections covered?

Are there adequate handholds?

C. Electrical System

Are all the cables and connections labeled?

Are all cables adequately restrained or clamped?

Are the cables of adequate length?

Do the cables have adequate strain relief?

Are protection devices (circuit breakers and fuses) provided for each piece of equipment?

Are all components labeled?

Are the high voltage sources protected and marked with warning labels?

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 153 of 165

Is the equipment properly grounded?

Are the batteries of the proper type (dry or gel cell only--no liquid electrolyte or lithium)?

Is all insulation properly protected against abrasion?

D. Lasers

Are the type, manufacturer, peak power, pulse length, voltage requirement, and mode of operation documented?

Does the laser comply with ANSI-Z-136.1?

Are interlocks provided?

Is it marked with warning labels?

E. RF Systems

Has an EMC test been conducted?

F. Pressure Systems

Are the design pressure and MAWP specified?

Is the system guarded against any component inadvertently exceeding MAWP?

Does the system have over-pressure protection (automatic controls, relief valves)?

Has the pressure vessel been certified to ASME standards?

Is the certification current? Is the following relief device information included:

Set pressure?

Manufacturer?

Model number?

Component number?

Are the relief devices tagged with the set pressure?

Is the following information included for other components such as valves, regulators, filters, etc:

Manufacturer?

Model number?

Pressure rating?

Component number?

Have the regulator gauges been certified and tagged or labeled?

Have the pressure gauges been certified and tagged or labeled?

Has proof testing been performed for the following components:

Pressure vessels?

Flex hoses?

Piping system?

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 154 of 165

Relief valves?

Has proof testing been performed for the fully configured system?

G. Vacuum system

Are the drawings included?

Is the system equipped with relief devices (positive or negative relief valves)?

H. Hazardous Materials

(If possible, avoid high pressure, toxic, corrosive, explosive, radioactive, and flammable materials!)

Is the absolute minimum quantity used for the experiment?

Are the MSDS's included?

Are the materials properly contained?

I. Breakable Items

Are glass monitor screens covered with $\geq 1/16$ -inch Lexan or Plexiglass? Is all glass tubing wrapped or contained properly?

Are any high-temperature viewing ports made of tempered glass?

Are any other viewing ports made of Lexan or Plexiglass?

J. Cleanliness

Is the test article free from drilling debris, excess tape, dust, and loose items (tools, pencils, pens, paper clips, etc)?

K. ADP

Are the manuals included?

L. Transportation

Are the manuals included?

Is the test article properly secured, padded, and ready for transportation?

Are storage bottles, if any, empty (at zero pressure) for transport?

If not, do they meet DOT regulations?

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 155 of 165

Appendix J
JSC Form 473A
NASA/JSC Badge Request Form

This form is for use by foreign nationals who are citizens of countries that are NOT on the Designated Area List.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 156 of 165

NASA/JSC BADGE REQUEST FORM						
PART 1 – TYPE OF BADGE (Check only one box)						
BADGE TYPE	Government	Contractor	Foreign National or Foreign Representative (US citizen employed by foreign owned company)		Official Visitor	
	<input type="checkbox"/> PERMANENT <input type="checkbox"/> TEMPORARY <input type="checkbox"/> CO-OP	<input type="checkbox"/> PERMANENT <input type="checkbox"/> TEMPORARY	<input type="checkbox"/> INTERNATIONAL VISITOR (Short-term = 1-89 days) <input type="checkbox"/> INTERNATIONAL VISITOR (Long-term = 90 days-1 yr.) <input type="checkbox"/> INT'L VISITOR- REPEAT/RECURRING VISITS <input type="checkbox"/> INTERNATIONAL EMPLOYEE (Short term = 1-89 days) <input type="checkbox"/> INTERNATIONAL EMPLOYEE (Long-term = 90 days-1 yr.) EMPLOYEES: Attach copy of Employment Authorization		<input type="checkbox"/> SHORT-TERM (1-89 days) <input type="checkbox"/> LONG-TERM (90 days-1yr.)	
PART 2 - EMPLOYEE/VISITOR INFORMATION						
NAME:	(Last)		(First)		(Middle – mandatory)	
EMPLOYER/AFFILIATION:		PHONE NO.:	CITIZENSHIP:	RESIDENT ALIEN NO. (attach copy of Res. Alien Card or LPR Status on		
DOB	SEX:	EYES	HAI	HT.	WT.:	
POB:	SSN:	ALIEN REG. NO.:	PASSPORT NO.:	VISA or EMPL. AUTH. TYPE:		
			EXP	EXP DATE:		
PART 3 - ACCESS REQUIRMENTS/JUSTIFICATION						
JSC CONTRACT/GRANT NO., PROGRAM, PURPOSE OF VISIT, OR JUSTIFICATION FOR ACCESS:						
SUBCONTRACT NO. (If Applicable):			DESCRIPTION OF DUTIES (For all Non-US Employees):			
START DATE:	EXPIRATION DATE:	BUILDING ACCESS:	POINT OF CONTACT & PHONE NO.:			
PART 4 - AUTHORIZED OFFICIAL (JSC Sponsor, OPOC, FSO or Designated						
(Printed Name of Company Official –required for Contractor or Subcontractor organizations only)		(Signature)	(Company Name & Title)	(Date)	(Phone No.)	
(Printed Name of Approving Official –if applicable)		(Signature)	(Company Name & Title)	(Date)	(Phone No.)	
PART 5 - CENTER EXPORT ADMINISTRATOR OR DESIGNATED REPRESENTATIVE						
CONCUR	<input type="checkbox"/>	NONCONCUR	<input type="checkbox"/>	COMMENTS:		
(Printed Name)	(Signature)	(Title)	(Date)	(Phone No.)		
PART 6 - AUTHORIZED JSC IVC / SECURITY OFFICIAL						
(Printed Name)	(Signature)	(Title)	(Date)	(Phone No.)		
Type of Access <input type="checkbox"/> Escort Required <input type="checkbox"/> Non-Escort Required						
PART 7 - EMPLOYEE/VISITOR ACKNOWLEDGEMENT						
I understand that the badge I am to receive is the property of the U.S. Government and that it must be returned at the time of termination, transfer, or whenever the need for it no longer exists, or whenever instructed to do so by JSC Security. I fully realize that falsification of this form or any alteration or misuse of this badge is a violation of Section 499, Title 18, U.S. Code, and I may be prosecuted for this offense. I will abide by all security instructions and accept escort whenever required.						
Employee/Visitor Signature:				Date:		
FOR SECURITY BADGE OFFICE USE ONLY Verify that this is the correct version before use.						
Date	Time In	Issued By	Comments (if applicable)			
JSC Form 473A (Rev September 15, 1999) (MS Word, June 1999)				[Privacy Act Statement - See Page 2]		

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 157 of 165

"INFORMATION SUBJECT TO THE PRIVACY ACT OF 1974

Information requested on JSC Form 473A is authorized by PL 85-568 and PL 81-733; 18 USC 793-799; 18 USC 2151-2157; 18 USC 371; 18 USC 202-208 and 3056; 42 USC 2473; 44 USC 3101; 14 CFR 1203a; 41 CFR 101-11; and related Agency regulations.

The information being provided pursuant to Public Law 93-579 (Privacy Act of 1974) is used within NASA for individual personal identification and for granting security clearances; for determining qualifications for access to classified information, security areas, and other NASA installations/facilities. JSC Form 473A will be used and maintained in the NASA 10SECR System of Records as published in the Federal Register Notice of Privacy Act Systems of Records.

Failure to provide information (i.e., complete name, social security number, etc.) will result in disapproval of this request." False Statements are subject to denial of request and/or criminal penalties (See 5 USC 552a(i)).

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 158 of 165

Appendix K

JSC Form 473B

NASA/JSC Request Form for Foreign National Visitors/Employees From Designated Areas

This form is for use by foreign nationals who are citizens of countries that are listed on the Designated Area List.

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 159 of 165

NASA/JSC BADGE REQUEST FORM FOR FOREIGN NATIONAL VISITORS/EMPLOYEES FROM DESIGNATED AREAS						
PART 1 - EMPLOYEE/VISITOR INFORMATION						
NAME: (Last)		(First)		(Middle – mandatory)		
EMPLOYER/AFFILIATION:		PHONE NO.:		CITIZENSHIP:		
DOB	SEX	EYES	HAI	HT.	WT.:	
POB:	SSN:	ALIEN REG. NO.:	PASSPORT NO.:	VISA or EMPL. AUTH. TYPE:		
			EXP	EXP DATE:		
PART 2 - ACCESS REQUIREMENTS/JUSTIFICATION						
JSC CONTRACT/GRANT NO., PROGRAM, PURPOSE OF VISIT, OR JUSTIFICATION FOR ACCESS:						
SUBCONTRACT NO. (If Applicable):		DESCRIPTION OF DUTIES (For all Non-US Employees):				
START DATE:	EXPIRATION DATE:	BUILDING ACCESS:	POINT OF CONTACT & PHONE NO.:			
PART 3 - AUTHORIZED OFFICIAL (JSC Sponsor, OPOC, FSO or Designated)						
(Printed Name of Company Official –required for Contractor or Subcontractor organizations only)	(Signature)	(Company Name & Title)	(Date)	(Phone No.)		
(Printed Name of Approving)	(Signature)	(Company Name & Title)	(Date)	(Phone No.)		
PART 4 - CENTER EXPORT ADMINISTRATOR OR DESIGNATED REPRESENTATIVE						
CONCU <input type="checkbox"/>	NONCONCU <input type="checkbox"/>	COMMENTS/RECOMMENDATION				
(Printed Name)	(Signature)	(Title)	(Date)	(Phone No.)		
PART 5 – NASA HQ'S ASSESSMENTS & TECHNOLOGY DIVISION (Code ID)						
CONCU <input type="checkbox"/>	NONCONCU <input type="checkbox"/>	COMMENT				
(Printed Name)	(Signature)	(Title)	(Date)	(Phone No.)		
PART 6 – TYPE OF BADGE AND AUTHORIZED JSC IVC/ SECURITY OFFICIAL						
Foreign National or Foreign Representative (US citizen employed by foreign-owned company) – CHECK ONLY ONE						
<input type="checkbox"/> INTERNATIONAL VISITOR (Short-term = 1-89 days)		<input type="checkbox"/> INTERNATIONAL EMPLOYEE (Short term = 1 – 89 days)				
<input type="checkbox"/> INTERNATIONAL VISITOR (Long-term = 90 days to 1		<input type="checkbox"/> INTERNATIONAL EMPLOYEE (Long-term = 90 days – 1 year)				
<input type="checkbox"/> VISITS (Intermittently - up to one year)		EMPLOYEES: Attach copy of Empl. Auth. Document				
Type of Access Approved:		<input type="checkbox"/> Escort Required <input type="checkbox"/> Non-Escort Required				
(Printed Name)	(Signature)	(Title)	(Date)	(Phone No.)		
PART 7 - EMPLOYEE/VISITOR ACKNOWLEDGEMENT						
I understand that the badge I am to receive is the property of the U.S. Government and that it must be returned at the time of termination, transfer, or whenever the need for it no longer exists, or whenever instructed to do so by JSC Security. I fully realize that falsification of this form or any alteration or misuse of this badge is a violation of Section 499, Title 18, U.S. Code, and I may						
Employee/Visitor Signature:			Date:			
FOR SECURITY BADGE OFFICE USE ONLY						
Date	Time In	Issued By	Comments (if applicable)			
JSC Form 473B (Rev September 15, 1999) (MS Word, June 1999)			[Privacy Act Statement - See Page 2]			

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 160 of 165

"INFORMATION SUBJECT TO THE PRIVACY ACT OF 1974

Information requested on JSC Form 473B is authorized by PL 85-568 and PL 81-733; 18 USC 793-799; 18 USC 2151-2157; 18 USC 371; 18 USC 202-208 and 3056; 42 USC 2473; 44 USC 3101; 14 CFR 1203a; 41 CFR 101-11; and related Agency regulations.

The information being provided pursuant to Public Law 93-579 (Privacy Act of 1974) is used within NASA for individual personal identification and for granting security clearances; for determining qualifications for access to classified information, security areas, and other NASA installations/facilities. JSC Form 473B will be used and maintained in the NASA 10SECR System of Records as published in the Federal Register Notice of Privacy Act Systems of Records.

Failure to provide information (i.e., complete name, social security number, etc.) will result in disapproval of this request." False Statements are subject to denial of request and/or criminal penalties (See 5 USC 552a(i)).

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 161 of 165

APPENDIX L

JSC CUSTOMER FEEDBACK

The Reduced Gravity Office seeks to provide the best service possible to its customers; to that end, your comments, questions, and suggestions are always invited. You are encouraged to submit both the Reduced Gravity Office feedback form (obtained from the Reduced Gravity Office) to the Reduced Gravity Office and JSC Form 902 on the following page to the address at the bottom of the form. Your feedback will be kept confidential and responded to as appropriate.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 162 of 165

JSC Customer Feedback

JSC is strongly committed to providing quality products and services.
We'd like to know how you think we are doing. You can tell us by filling
out this Customer Feedback Form.

Customer Name	Organization
Mailing Address	Phone Number
	E-Mail Address
JSC Provider	Organization
Mailing Address	Phone Number
Were you satisfied with the products? <input type="checkbox"/> Yes <input type="checkbox"/> No	
Your Comments:	
If your requirement(s) were not met, please provide the following additional information:	
Requirement Document Title:	
Reference Paragraph No.:	
Requirement:	
Description of Problem:	
JSC Form 902 (Rev Feb 98) (MS Word May 97)	Please, mail Mail _____ Attention: _____ NASA - Johnson Space Center 2101 NASA Road 1

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 163 of 165

INDEX

- 115 VAC, 400 Hz, 37
- 115 VAC, 60 Hz, 34
- 28 VDC, 35
- Accelerometer Pin Designations, 41
- Accelerometer Signal, 41
- Accident and Life Insurance Notification, 58
- Acknowledgements, 5
- Aircraft, 28
- aircraft floor footprint, 65
- Aircraft Floor Layout, 30
- Aircraft G-Load Display, 40
- Aircraft Lighting, 38
- Aircraft Loading, 64, 81, 95
- Aluminum floor spacers, 61
- Any glass, 76
- Approval Questionnaire, 8, 51, 59, 101
- at Ellington Field, 24, 39, 47, 55, 97
- Badging Requirements, 54, 55
- Bibliography, 98
- Blue flight suits, 25
- Building 993, 12, 24, 45, 46, 47, 48, 51, 56, 57, 96, 99, 100
- Cabin Dimensions, 29
- cabin pressure, 76
- Cabin Provisions, 33
- Cargo Door Dimensions in Inches, 33
- Cargo Strap Schematic, 62
- Category A Design Requirements. *See* Pressure System Design Requirements
- Category A Documentation Requirements, 88
- Category A Test and Inspection Requirements, 69
- Category B Design Requirements. *See* Pressure System Design Requirements
- Category B Documentation Requirements, 89
- Category B Test and Inspection Requirements, 69
- Category C Design Requirements. *See* Pressure System Design Requirements
- Category C Documentation Requirements, 89
- Category C Test and Inspection Requirements, 69
- Category D Design Requirements. *See* Pressure System Design Requirements
- Category D Documentation Requirements, 89
- Category D Test and Inspection Requirements, 69
- Category E Design Requirements. *See* Pressure System Design Requirements
- Category E Documentation Requirements, 89
- Category E Test and Inspection Requirements, 69
- Class Designation. *See* Lasers
- Classification Requirements, 65
- Cleaning Equipment for Zero-G Flight, 78
- Computers, Network Access, Printers, and Phones, 46
- Containment of Loose Parts and Equipment, 78
- contingency procedures, 77
- Cover Page, 82
- Crane and Scale, 47
- Cross-Section of Fuselage Station 710 and Aft, 31
- Cross-Section of Fuselage Station 710 and Fwd, 32
- Cryogenic Storage and Supply System, 46
- DB-15 Accelerometer Data Connector, 41
- digital images, 43
- Drinking water, 77
- Electrical, 10, 14, 34, 70, 81, 86, 87, 151
- electrical power during engine, 70
- electrical power loss, 70, 87
- Ellington Field, 11, 12, 24, 25, 28, 39, 45, 46, 47, 49, 51, 55, 56, 57, 59, 64, 66, 68, 76, 95, 96, 97, 99
- Emergency Procedures, 75
- EMI/RFI Checks, 78
- Environment. *See* Aircraft Environment 3.1.1
- Equipment Description, 84
- Equipment Labels. *See* Lasers
- Expansion Box 28 VDC Interfaces, 36
- Experiment Description, 84
- Experiment Procedures Documentation, 97

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 164 of 165

FACILITIES PROVIDED, 28
 Feasibility of Flying Inquiry, 51
 Flight Crew, 26
 Flight Manifest, 84
 Flight Medicine, 49, 135
 Flight Surgeon Crew Duties, 49
 Floor Attachment Hardware, 10, 61
 Flow Rates, 10, 39, 73
 Foot straps, 77
 Foreign Nationals, 56
 forklift, 48, 64, 95, 97
 Free Body Diagrams, 61
 Free Float, 72, 81
 Funding, 58
 Furniture Dolly (24" x 44"), 48
 gas systems, 38, 39
 Glenn Research Center Operations, 139
 Glenn Research Center Provided Support, 140
 G-Load Specifications, 61
 Ground Facilities, 45
 Ground Support Requirements, 96
 Ground Tools, 48
 Hardware / Specialty Stores, 23
 Hazard Analysis Report Guidelines, 91
 Hazard Control, 92, 94
 HAZARD SOURCE CHECKLIST, 93
 Hazardous Materials, 75, 96
 High Lift truck, 64
 High Lift Truck, 48
 High Pressure Gas System, 38
 Hotels, 21
 Human Research Master Protocol, 8, 52, 91
 HUMAN RESEARCH MASTER
 PROTOCOL, 129
 Human Research Policy, 25
 Human Research Protocol, 52
 In-Flight, 99
 Information on How to Apply for NASA
 Microgravity Research Grants, 12
 Initial Test Request, 51
 Institutional Review Board (IRB), 91
 Introduction, 11
 J-Bars, 48, 96
 Johnson Space Center Requirements, 24
 JSC Form 473a, 56, 57
 JSC Form 473b, 56
 JSC Institutional Review Board, 12, 25, 52, 91, 134
 JSC Safety Manual, 12, 70
 K-bottle, 38
 k-bottles, 38, 88
 K-bottles, 38, 39, 96
 KC-135, 5, 11, 12, 24, 25, 26, 28, 38, 44, 45, 48, 49, 51, 53, 54, 57, 58, 59, 60, 61, 62, 64, 65, 66, 67, 69, 74, 75, 76, 77, 78, 79, 80, 81, 83, 84, 89, 91, 92, 95, 98, 101, 103, 104, 107, 108, 112, 113, 132, 139, 140, 149, 151
 Laser, 74, 81, 90
 Lead acid batteries, 76
 Lifting Pipe, 48
 Lifting Straps, 48
 Load Tables, 86
 Loading Assistance Tools, 48
 Local Area Information, 16
 Local Area Maps and Hotel and Restaurant Information for GRC, 144
 Map of Clear Lake, 16
 Map of Johnson Space Center, 18
 Map of Ellington Field, 17
 Material Safety Data Sheets (MSDS), 97
 Material yield strengths, 61
 Medical and Physiological Documentation, 55
 Medical Facilities, 49
 Medical Requirements, 53
 MEDICAL REQUIREMENTS, 103
 Miscellaneous Guidelines, 76
 Mishap Form, 57
 MISSION STATEMENT, 4
 Motion Sickness Medication, 49
 NASA/JSC HUMAN RESEARCH INFORMED, 134
 Noise Level Evaluation, 79
 Normal Duty Hours, 46
 Normal Duty Hours Building 101, 140
 Oil lubricated pumps, 76
 On-Board Tools, 42
 Operations at Glenn Research Center – Cleveland, Ohio, 139
 Overboard Vent, 10, 39, 40, 72, 73, 83
 Overboard Vent System, 39
 Pad all hard and sharp edges, 76
 Parabola Details and Crew Assistance, 90

Verify that this is the correct version before use.

Aircraft Operations Division User's Guide	JSC Reduced Gravity Program User's Guide	
	Doc. No. JSC 22803	Rev. D
	Date: October 2000	Page 165 of 165

Permanent Resident Aliens, 55
 Personal camcorders and cameras, 77
 Photo Requirements, 95
 Photographic and Videographic Support, 42
 PHOTOGRAPHIC SUPPORT, 42
 PHYSIOLOGICAL TRAINING OUTLINE, 122
 Physiological Training Requirements, 3, 54
 Picture of Cargo Door Operations, 33
 Post-Flight, 100
 Power Distribution Panel, 34
 Power Panel 28 VDC Interfaces, 35
 Pre-Flight, 99
 PRE-SHIPMENT EQUIPMENT
 READINESS CHECKLIST, 151
 Pressure System Design Requirements, 66
 Pressure System Test and Inspection
 Requirements, 68
 Pressure/Vacuum System Documentation
 Requirements, 87
 Pressure/Vacuum System Requirements, 65
 Protective Housings. *See* Lasers
 Purpose, 11
 Quick Reference Data Sheet, 82
 Reduced –Gravity Aircraft Operations
 Office – Building 101, 140
 Reduced Gravity Office, 12, 14, 24, 25, 35, 39, 40, 43, 44, 45, 46, 47, 48, 49, 51, 52, 55, 56, 57, 58, 59, 61, 65, 66, 68, 71, 72, 73, 74, 75, 76, 77, 81, 87, 88, 89, 90, 95, 96, 97, 99, 100, 138, 160
 Reduced Gravity Office Contact
 Information, 12
 Restaurants, 19
 Roller Pipe (schedule 40 PVC), 48
 SAFETY POLICY, 24
 S-band downlink, 44, 95
 Schematic, 86
 Scope, 12
 Security, 24, 46, 56, 143, 155, 158
 Security and Access to Glenn Research Center, 141
 Shipping and Receiving, 47
 Shipping, Receiving and Storage at GRC, 143
 Spacers, 61, 63
 Standard duct tape, 76
 Storage (Including Chemicals), 46
 Structural Analysis, 85
 Table of Contents, 84
 Telephones at GRC, 141
 TELEVISION SUPPORT, 43
 Test Cabin Floor Schematic, 62
 TEST DESIGN REQUIREMENTS, 60
 Test Equipment Data Package, 11, 14, 25, 39, 42, 59, 60, 65, 72, 73, 78, 81, 82, 84, 85, 87, 88, 89, 90, 91, 95, 96, 97, 98
 TEST EQUIPMENT DATA PACKAGE
 REQUIREMENTS, 81
 test equipment design specifications, 60
 Test Equipment Structural Design
 Requirements, 60
 TEST OPERATIONS, 99
 Test Personnel Data GRC, 149
 Test Personnel Requirements, 53
 Test Readiness Review, 8, 14, 25, 26, 27, 59, 68, 69, 70, 87, 89, 97
 Test Request Procedure, 51
 Timeline, 59
 Tool Requirements, 95
 Touch Temperature for Research Hardware, 79
 U.S. Citizens, 55
 USER REQUIREMENTS, 51
 User Tools, 75
 Velcro, 76
 Video Copies, 44
 Viewing Portals and Collecting Optics. *See* Lasers
 Visitors, 56, 57, 157
 volumetric flow rates, 39, 40, 73
 Zerog Video Dub Request Form, 138
 zerogl@jsc.nasa.gov, 12, 51, 57, 138